ORDNANCE

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Snark Goes A-Hunting

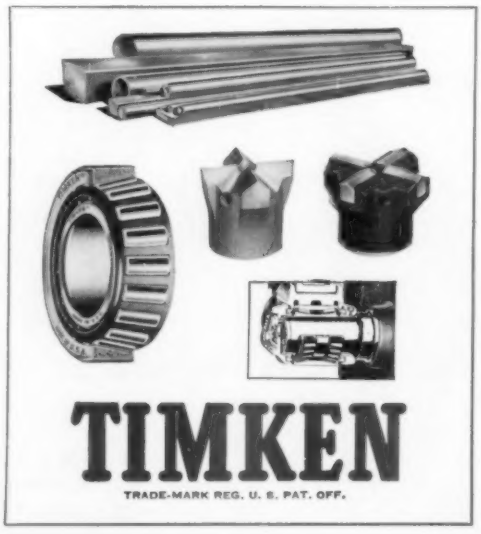
JULY-AUGUST 1956

(In two sections: Section I)

You mean what you say, when you say "TIMKEN"

IF you are content with just any old kind of tapered roller bearing, steel or rock bit, of course you don't specify "Timken". By the same token, when you want highest quality you don't specify anything *but* "Timken". To make sure you get what you want—to safeguard your reputation and ours—we stamp "Timken" on every product we make. When you say "Timken" we know you *mean* a product made by the Timken Company . . . because as everyone is aware, "Timken" is a trade-mark, not *just a type of product.*

When you purchase tapered roller bearings, alloy steel bars, seamless steel tubing or removable rock bits, always look for this famous legal identification. When you see it, you know there are over 55 years of experience behind it. When you *say* it, you're saying exactly what you mean: "I want the best." The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".



TAPERED ROLLER BEARINGS • REMOVABLE ROCK BITS • FINE ALLOY STEELS

ORDNANCE

LAND · SEA · AIR

The Magazine of Scientific and Industrial Preparedness Now in Its 37th Year

VOL. XLI JULY-AUGUST 1956 NO. 217

The Cover.—*The booster rockets of the Air Force Snark SM-62 intercontinental guided missile blast off to start it on a test flight from Patrick Air Force Base, Fla. Powered by an air-breathing jet engine, Snark can carry a nuclear warhead.*

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FEATURES

Snark Goes A-Hunting . . . . . Front Cover
The Air Force SM-62 intercontinental guided missile

Eger V. Murphree, Special Assistant for Guided Missiles Frontispiece
Exclusive photograph for ORDNANCE *by Harris & Ewing*

The Guided Missile Era 35
Development problems are in process of solution

Retaliation or Defense? . . . **Maj. George Fielding Eliot** 36
We must maintain both offensive and defensive power to protect our Nation

Fallout from the A-Bomb . . . . **Dr. Willard F. Libby** 40
The major part of radioactivity is dissipated in the stratosphere

Civilians in Atomic War . . . . . **Neil P. Hurley, S.J.** 44
We must return to the traditional doctrine of immunity of noncombatants

The Thirty-eighth Annual Meeting 49
Announcement of "Ordnance Day 1956" at Aberdeen Proving Ground

High-Speed Air Power 50
Photographs of the Snark guided missile and the F-104 supersonic fighter

Aircraft Carriers Today . . . . . **Charles P. Roane** 51
Modern weapons have increased the value of the mobile floating air base

Keeping Our Guard Up . . **Maj. Gen. Edgar C. Erickson** 55
Maintaining the weapons of the Air and Army National Guard

A New Training Program **Lieut. Col. H. R. Dichtenmueller** 59
Ordnance is grooming officers by graduate study and on-the-job experience

Army Missile Power 61
Photographs of the Honest John and the Corporal surface-to-surface weapon

"Miracle of World War II" **Brig. Gen. Donald Armstrong** 62
A review of Francis Walton's book on American industrial achievements

Armament Preparedness . . . . . **An Editorial** 67
Science-Industry-Ordnance teamwork is necessary for national survival

Navy Sea Power Today 68
Photographs of the JOHN PAUL JONES *and the guided-missile cruiser* BOSTON

DEPARTMENTS

Atomic Energy	28	**Rockets and Guided Missiles**	110
Defense Highlights . . .	64	**Armament Electronics** . .	114
Association Affairs . . .	69	**Recent Patents**	118
New Developments . . .	92	**Book Reviews**	122
Materials Progress . . .	102	**Index of Advertisements** .	183

ARMAMENT TECHNOLOGY

Ultrasonic Detective **C. H. Hastings and Sgt. R. W. Buchanan** 167
New device plots flaws in thick armor castings with speed and accuracy

Development of Air Power . **Col. W. L. McCulla, U.S.A.F.** 169
Achievements of the Arnold Engineering Development Center

New TNT Loading Method . . . . . **Col. O. M. Jank** 174
Advantages of a continuous melt pour process using flaked explosive

Automotive Gas Turbines . . . **2nd Lieut. Richard L. Curl** 177
New propulsion may soon be applied to commercial and military vehicles

Q: *How to heat vehicles?*

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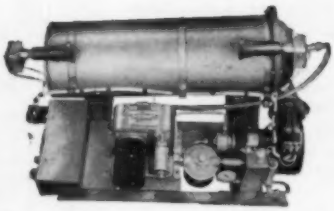

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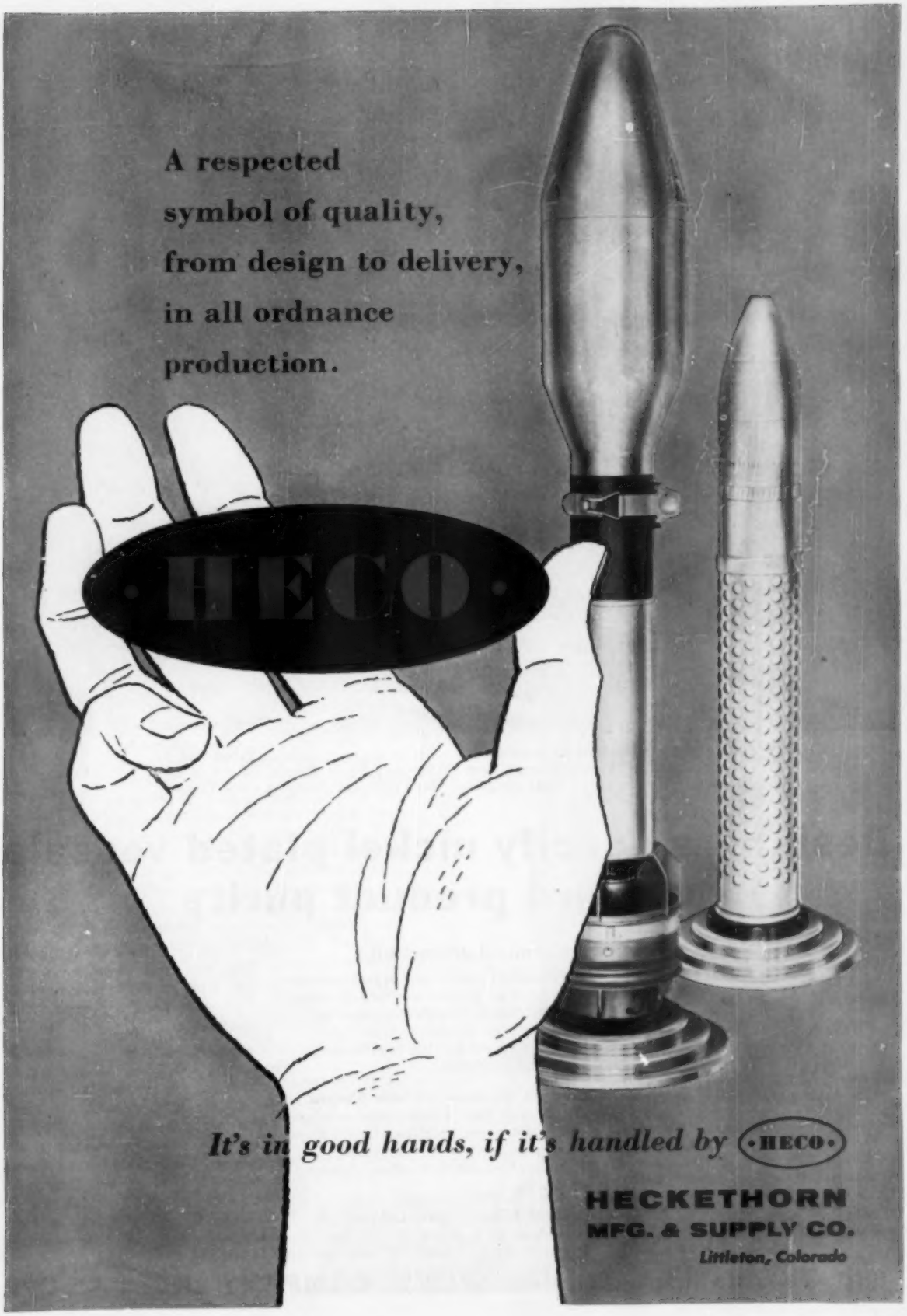
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Littleton, Colorado

Nickel plated inside and out to meet rigid specifications of Atomic Energy Commission, these pressure vessels comprise one of many trainloads fabricated by Newport News Shipbuilding and Dry Dock Company, Newport News, Virginia.

Designers specify nickel plated vessels to guard product purity

Designers, along with plant operators in scores of industries, find that a reasonable thickness of nickel plating helps in three ways:

First, by guarding equipment against mild corrosive attack.

Secondly, by protecting product purity during the production cycles.

And last but not least, by providing such protection economically.

Operators of food, chemical, petroleum and other process plants have made significant savings by use of nickel plated equipment.

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Heretofore, electroplating of large complex shapes posed several difficulties. But thanks to expansion and improvement of facilities, nickel plating is no longer limited to relatively small, simple forms.

Even on the most intricate shapes of low-cost base metals, new techniques now permit plating a uniform, extremely hard, corrosion-resisting coating of nickel that offers sturdy protection.

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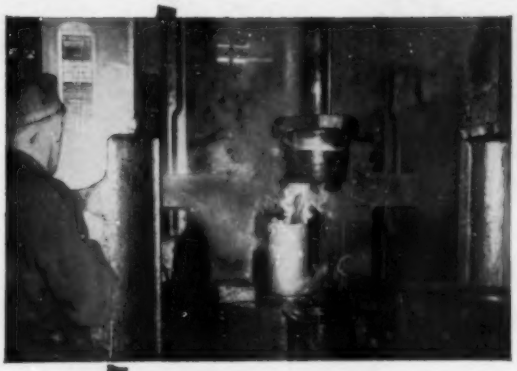

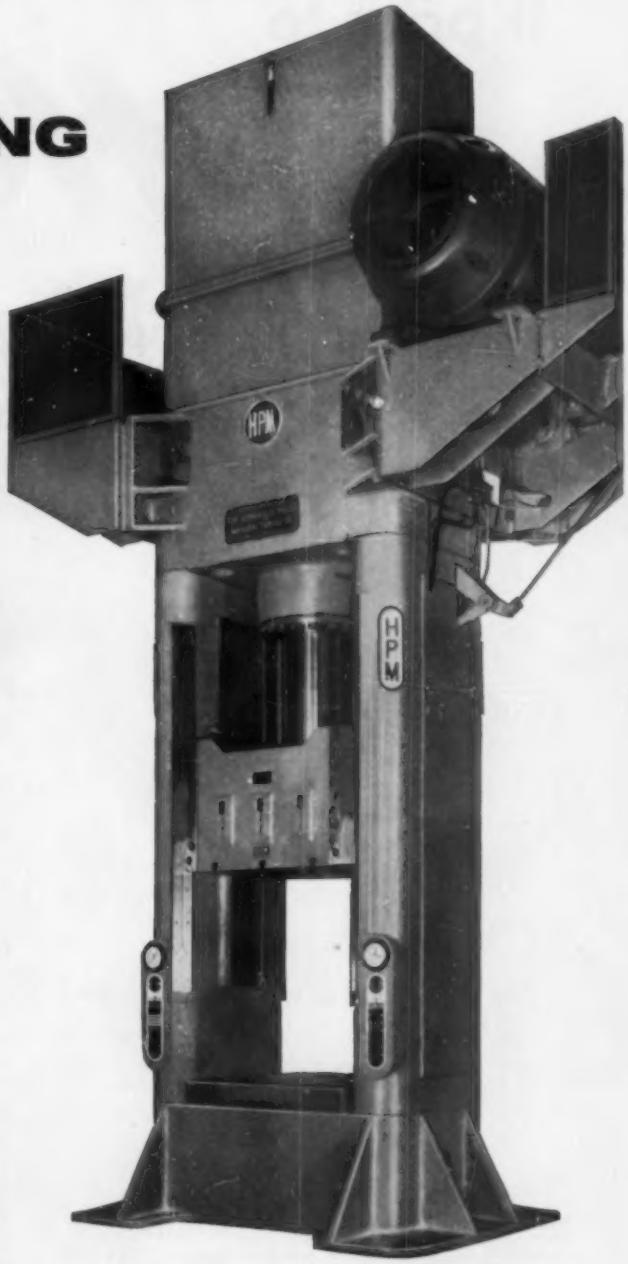

Here's a typical H-P-M Shell Forging Press. The press, tooling and engineered planning are H-P-M standards—standards that the ordnance industry accept with complete confidence assured through hundreds of successful installations. H-P-M designs and builds the entire press including tooling . . . a single responsibility. The application above shows a shell emerging from the die after the drawing operation. Close control of concentricity reduces original billet weight and in many cases machining time—an outstanding advantage of the H-P-M method. For complete engineering experience and a background in specialized ordnance equipment, contact your nearest H-P-M engineer or write the factory in Mount Gilead, Ohio.

Ask for Bulletin 5208 . . . H-P-M Forging Presses and processes completely illustrated.

METAL WORKING DIVISION
THE HYDRAULIC PRESS MFG. CO.
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. . . machine parts . . . subassemblies
. . . manufacturer of complete machines

Consider for a moment the pluses working for you when you specify HOE for machinery parts and complete machines. The experience of manufacturing printing presses for 150 years with the added knowledge of heavy ordnance and components production since 1847 offers dramatic proof of the confidence industry has placed in HOE. In addition, you have the extra advantage of fifteen years of practical knowledge in the manufacture of castings, machine parts, subassemblies and complete machines for more than 30 leading companies.

Do you need precision castings?

The HOE foundry offers you a capacity of 60 tons per day. Too, a complete staff of highly skilled engineers and metallurgists stand ready to provide you with gray iron, semisteel or alloyed castings . . . in the grade you desire . . . in the size you need.

If you require tolerances of ±.0005" in heavy machinery

Remember that every HOE machine is operated by a trained machinist accustomed to close tolerance assignments. And HOE shops are equipped with all the tools and facilities which modern machine shop practices dictate.

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Full information on the complete services which HOE provides may be obtained from the Contract Manufacturing Division, R. HOE & CO., INC., 910 East 138th Street, New York 54, N. Y. TELEPHONE: CYpress 2-2400.

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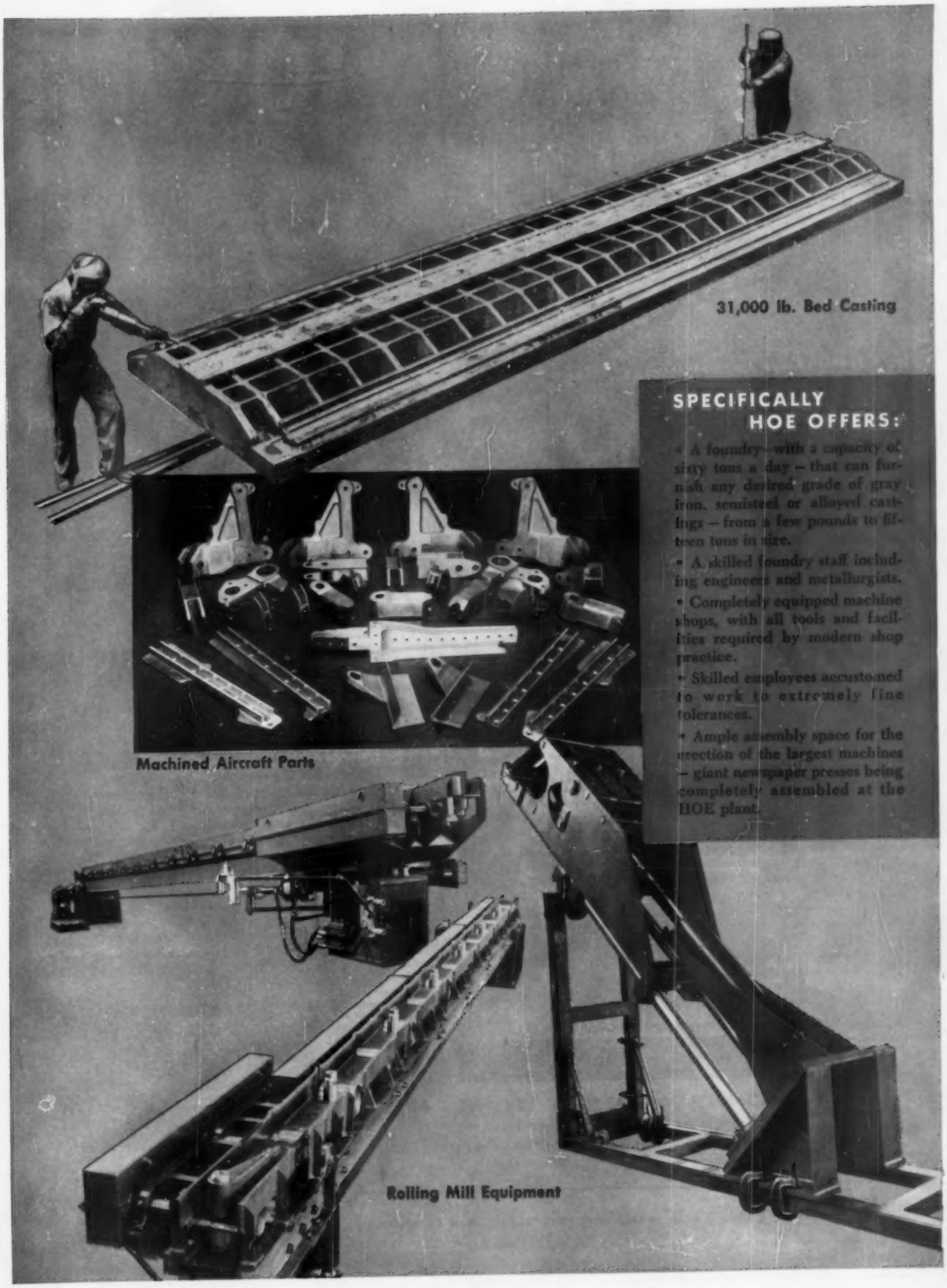
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• Completely equipped machine shops, with all tools and facilities required by modern shop practice.
• Skilled employees accustomed to work to extremely fine tolerances.
• Ample assembly space for the erection of the largest machines—giant newspaper presses being completely assembled at the HOE plant.
Machined Aircraft Parts
Rolling Mill Equipment

Official U. S. Navy Photograph

The U. S. S. Boston (CAG-1), the Navy's first guided missile cruiser, with Terrier Missiles and their launchers at the stern.

NAVY BUREAU OF ORDNANCE DEVELOPS WEAPON SYSTEMS FOR USE AGAINST ATTACK BY SEA OR AIR

The recent unveiling of the Navy's first ready-for-combat anti-aircraft guided missile weapon system —TERRIER—is but one result of the research and development work being done by the U. S. Navy's Bureau of Ordnance and a coordinated team of industrial and educational institutions.

From its establishment in 1842, the Bureau of Ordnance has provided the weapons with which the Navy has fought victoriously in six wars. With the evolution of armament, from the first muzzle loading cannons to today's complex weapons systems, it has directed the design, development, and production of the computers, fire control, and other types of equipment comprising the Navy's air, surface, and underwater ordnance.

The Research and Development Division of the Bureau of Ordnance has the responsibility of initiating and coordinating the research and development of the many projects which result in such end products as guided missiles, homing torpedoes, aircraft laid mines, and the launching and control systems for these weapons.

The job of guiding a key element of a modern day weapon system from the idea stage to the ready-for-combat stage involves a wealth of technology—drawing upon the skill, farsightedness, and courage of responsible scientific and technical personnel in the Bureau of Ordnance and its laboratories, and their counterparts in universities and industrial organizations.

This is one of a series of ads on the technical activities of the Department of Defense. 103

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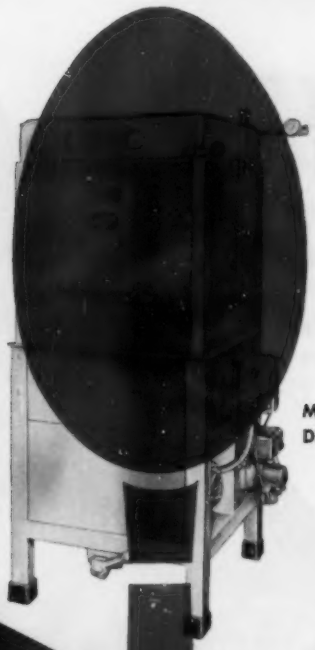

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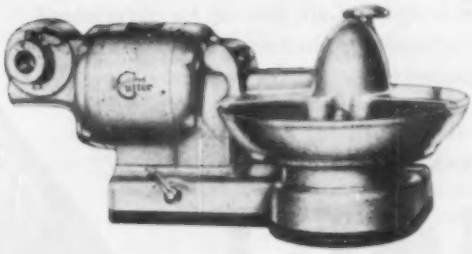

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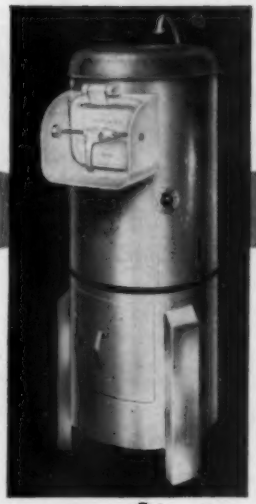

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. . . Meet necessary rigid standards

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N-A-X ALLOY STEELS in national defense equipment serve a dual purpose. First, they readily meet the rigid standards so necessary in this type of equipment. Second, while performing capably, these alloy steels do contribute greatly to our national economy through conservation of critical alloying elements.

N-A-X ALLOY STEELS are produced by Great Lakes Steel Corporation—long recognized specialists in flat-rolled steel products.

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Courtesy of Ingersoll Kalamazoo Division, Borg-Warner Corporation, Design Agent and Builder of LVT's.

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N-A-X Alloy Division

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Today, there are more Raytheon subminiature tubes and transistors in use than those of any other manufacturer. Raytheon is also the world's largest manufacturer of magnetron and klystron microwave tubes.

Raytheon's record in designing reliable electronic products for home, industry and the armed forces is, in substantial part, due to its pre-eminence in tubes and transistors.

Excellence in Electronics

RAYTHEON

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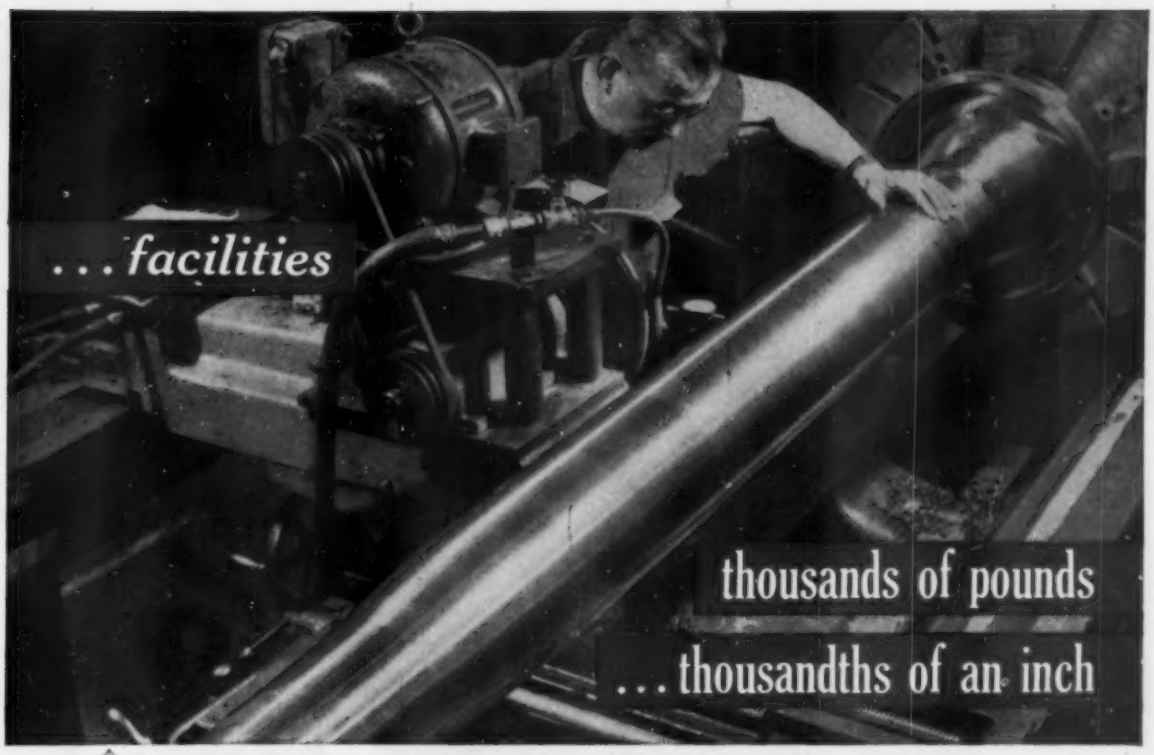

STEAM CATAPULTS FOR NAVY CARRIERS are made at Bliss' Canton plant. Shaft shown here is ground to special taper by mounting grinder on lathe post and guiding it with a specially built duplicating device.

20-mm MACHINE GUNS. Here, barrels are given a salt bath heat treatment in Bliss plant. In addition to production of 20-mm machine guns Bliss manufactures cartridge case and shell making machinery and other ordnance equipment.

NUCLEAR REACTOR CONTROL RODS produced for the AEC by Bliss. Production requirements involve unusually precise machining and welding practices.

Virtually no contract machining or fabrication job is too large for Bliss facilities. And Bliss' record of long experience and successful performance on past contracts, both civilian and military, is your assurance of precision craftsmanship. In short, before you decide who's going to build it, it's wise to get a bid from Bliss.

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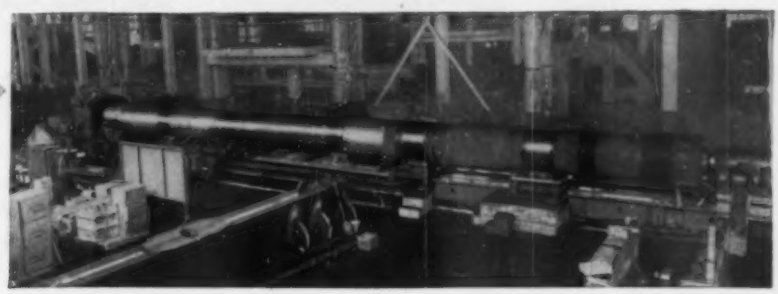
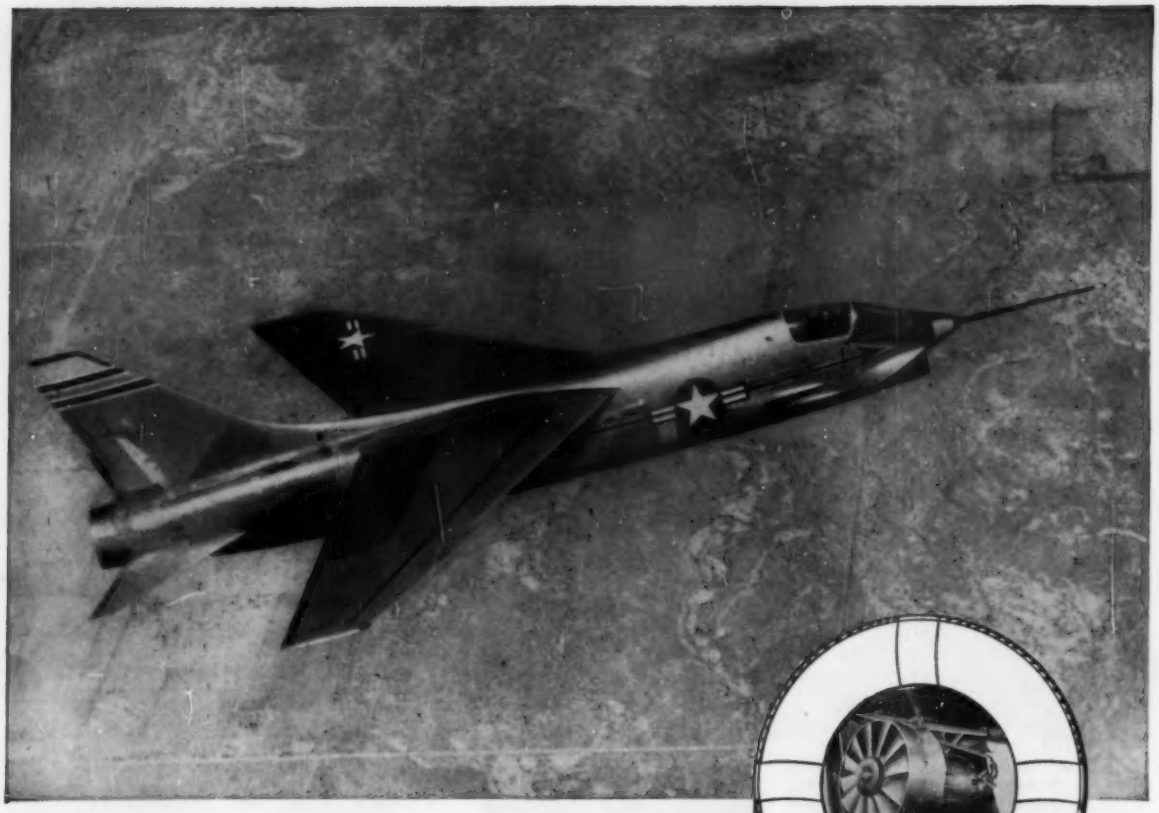
Add these facilities to your own: 11 plants • 2,000,000 sq. ft. • An estimated $44,000,000 inventory of modern tools • Two Meehanite foundries, one iron and one steel foundry • Two fully equipped welding departments.

140-TON FORGINGS. The 70-foot tie rods for the great hydraulic presses built under the Air Force Heavy Press Program filled little more than half the 120-foot bed of this huge engine lathe. It is one of the more-than-100 lathes in Bliss' 675,000 sq. ft. Canton, Ohio, plant.





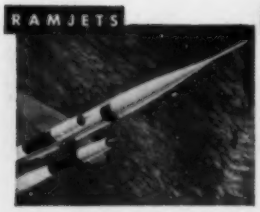
The Chance Vought F8U-1 Crusader, newest of the Navy's jet fighters, is equipped with a Marquardt ram-air emergency power package. In case of engine failure the unit pops into the air stream and supplies A-C, D-C, and hydraulic power sufficient to maintain flight control and communication through all speeds down to safe landing.

Lifesaver... WHEN POWER FAILS

Marquardt Aircraft, the West's largest jet engine research and development center, is an important contributor to the OMAR Joint Technical Committee. With Reaction Motors, first in the American rocket industry, and Olin Mathieson Chemical, a leading producer of chemicals, explosives, metals, Marquardt adds greatly to a continuous joint technical effort to achieve improved rocket and ramjet engines and special fuels. Exemplifying the weapons systems concept in action, the OMAR Committee combines for the first time both chemical and mechanical experience applicable to high-energy power generation.

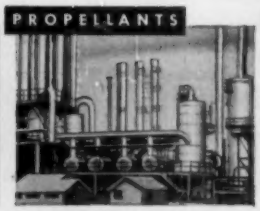
Engineers, chemists, physicists, production and tool specialists...a wide variety of fascinating careers await you on this weapons systems team. For information write OMAR Employment Officer at the company nearest you.

RAMJETS



Marquardt Aircraft Company
Van Nuys, California

PROPELLANTS



Olin Mathieson Chemical Corp.
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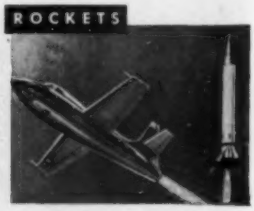
ROCKETS



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Phillips operates "Texas-size" facilities of latest design for rocket research, development, and production at McGregor, Texas. Our experienced staff is available to consult with the aircraft and missile industries on military problems and newer projects. We invite discussion of technical and production problems.

PHILLIPS PETROLEUM COMPANY
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Phillips 66

Address all inquiries to: **Rocket Fuels Division, McGregor, Texas.**

This "Big Stick" stops trouble before it starts

So powerful that it revises infantry strategy, the Douglas *Honest John* is an artillery rocket of tremendous destructive force and deadly accuracy.

Designed and built by Douglas Aircraft, Honest John moves into position on its own launching truck. This free-flight missile can carry the heaviest high explosive charge, or an atomic warhead in weather that grounds tactical air cover. Its very existence deters an enemy from massing for effective ground attack.

HONEST JOHN puts a mobile atomic weapon up front with the infantry

Development of Honest John by Douglas engineers fills a vital infantry need and provides new muscle for our armed forces. But the basic strength of any defense depends on the people manning it. Find out what an important future there is for *you* in U. S. Army service.

Depend on *DOUGLAS* **First in Aviation**

Defense, too, demands specialists in computation

Speak of modern defense systems and you speak of computation—the unerring, lightning-fast kind that makes it possible to guide missiles, aim guns, locate and intercept high-speed aircraft.

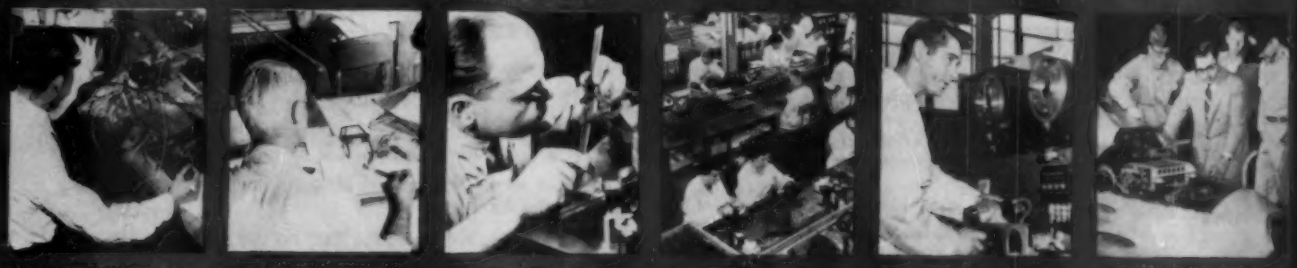
To evolve this kind of computation requires specialists, *plus* a completely integrated organization for research, development, engineering and tooling . . . for precision manufacturing, testing, field service and training.

These are the very skills and facilities that Burroughs has developed during its 70 years of dedication to computation . . . from the earliest business figuring machines to today's electronic computers.

Burroughs has consistently demonstrated its fitness to assume the prime responsibility for Armed Forces' projects involving instrumentation, control systems, communications, electronic computation and data processing. Further inquiries are welcomed. Burroughs Corporation, Detroit 32, Michigan.

BURROUGHS INTEGRATED DEFENSE FACILITIES INCLUDE:

Burroughs Corporation plants in Detroit and Plymouth, Michigan
Burroughs Research Center, Paoli, Pennsylvania
Burroughs Electronics Instruments Division, Philadelphia, Pennsylvania
Control Instruments Company, Brooklyn, New York
Haydu Brothers of New Jersey, Plainfield, New Jersey
The Todd Company, Inc., Rochester, N.Y.

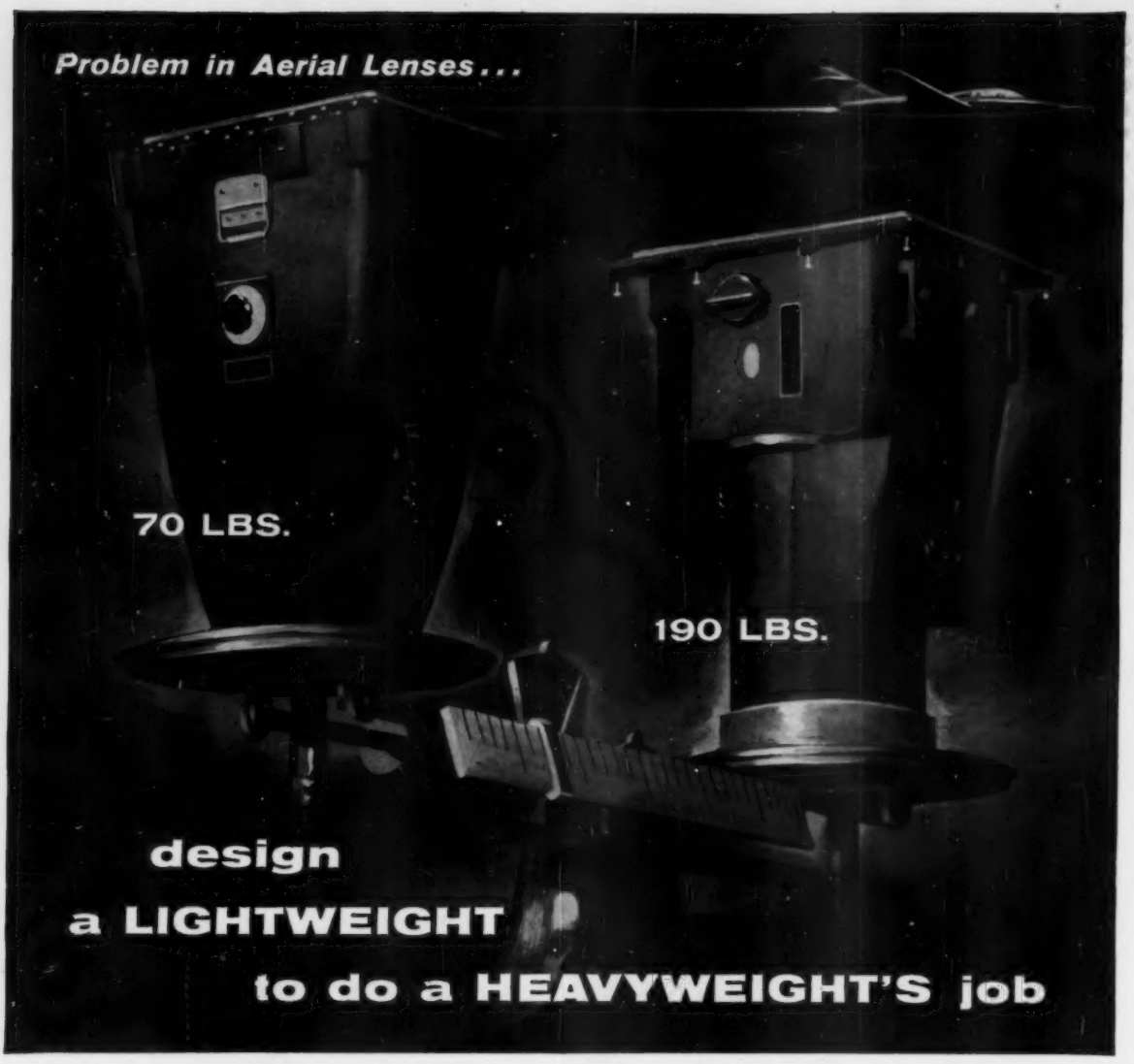


RESEARCH DEVELOPMENT ENGINEERING PRODUCTION TESTING FIELD TRAINING

Burroughs

The Foremost Name in Computation

Looking to future expansion, Burroughs invites inquiries from qualified engineers.



As part of its never-ending war on weight the Air Force handed Perkin-Elmer this problem: find a way to trim the fat off bulky aerial telephoto lenses — without impairing their optical performance.

Drawing on the experience of a staff that has designed and built some of the world's most complex optical and electro-mechanical equipment, P-E came up with a definitive report on lightweight lens techniques. Using these new techniques, P-E took a large lens system weighing 190 pounds, remanufactured it down to a cool 70 pounds — with no loss in optical performance!

Even more dramatic weight reductions are in the offing. P-E has recently developed a method for mass-producing aspheric lenses. This new method will make possible lens systems with greatly simplified optical elements. Here again, the answer was found by a P-E staff whose experience went far beyond mere specialization.

Other projects that testify to Perkin-Elmer's ability to take a systems problem and "see it whole":

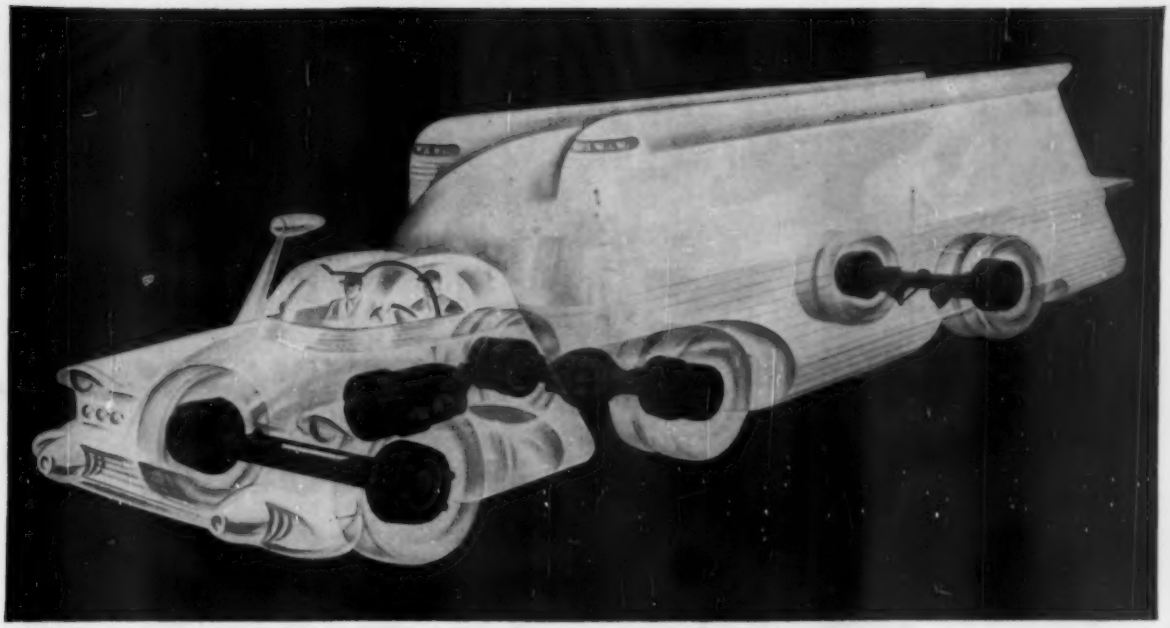
- ROTI Mark I (Recording Optical Tracking Instrument) for tracking the flight of guided missiles.
- Airborne infrared detection systems for military use.
- The Y-4 bombing periscope for the B-47.
- Prototype optical and radar bombing and navigation system now designated MA-2 for use on the B-52.
- Most of the large aerial photographic lenses in use today by the Air Force.
- Reactor periscopes for the Nautilus and Seawolf submarines.

In planning your next project, invite Perkin-Elmer to sit in. Our staff and unique facilities can bring your project to fulfillment sooner than you may now realize.

Perkin-Elmer
CORPORATION
NORWALK, CONNECTICUT

OPTICS • MECHANICS • ELECTRONICS

In planning your career also — consider Perkin-Elmer. We have openings for physicists, electronic engineers and many others. We can offer top opportunities for advancement in a rapidly growing organization, located where comfortable suburban living is a reality.



Good Engineering—aimed at MORE PROFITABLE PERFORMANCE

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Here is a business that has grown steadily, soundly, by making itself essential in a vital area of vehicle performance—engine torque transmission.

- **For more than 50 years Clark engineering has studied power transmission—those quiet, hard-working components that are the leg-muscles of revenue vehicles. Users of those components believe they are getting the best their money will buy. So do we.**

- **For 25 years and more Clark has been building materials handling equipment; and in later years, construction machinery—end-product machines using Clark power-transmission components. Again, users are convinced that those machines are better because of their Clark-engineered components. So are we.**

It is high approval of any working vehicle or machine to say that from engine flywheel to point of torque application, its power-train is engineered and manufactured by Clark Equipment.

That is why leading manufacturers say with conviction: It's **good business to do business with CLARK.**

CLARK EQUIPMENT COMPANY, Buchanan, Battle Creek, Jackson, Benton Harbor, Michigan

DESTINATION...

UNKNOWN!

Rockets to points in outer space! They are more than a dream. In fact, some morning before long you may wake up to find such rockets a reality.

Right now, AC engineers, together with some of America's top scientists, are hard at work developing electro-mechanical guidance systems that are capable of directing missiles to many points in outer space.

Fantastic? Not at all. AC has built a world-wide reputation with outstanding contributions in the fields of guidance, navigation and fire control.

AC is well on the way to development of control systems that can direct space-rockets on their way.

AC

THE ELECTRONICS DIVISION
OF GENERAL MOTORS
Flint, Michigan
Milwaukee, Wisconsin

Is your tubing bottleneck shown here?

Bundy Engineers and versatile Bundyweld Tubing can beat the knottiest tubing design problem!

If you think it can't be done with tubing, it's a challenge to Bundy. For years, Bundy Engineers have specialized in working with customers and prospects, solving the insolvable. A unique combination of imagination and experience, plus the extreme versatility of Bundyweld Steel Tubing, has paid off again and again.

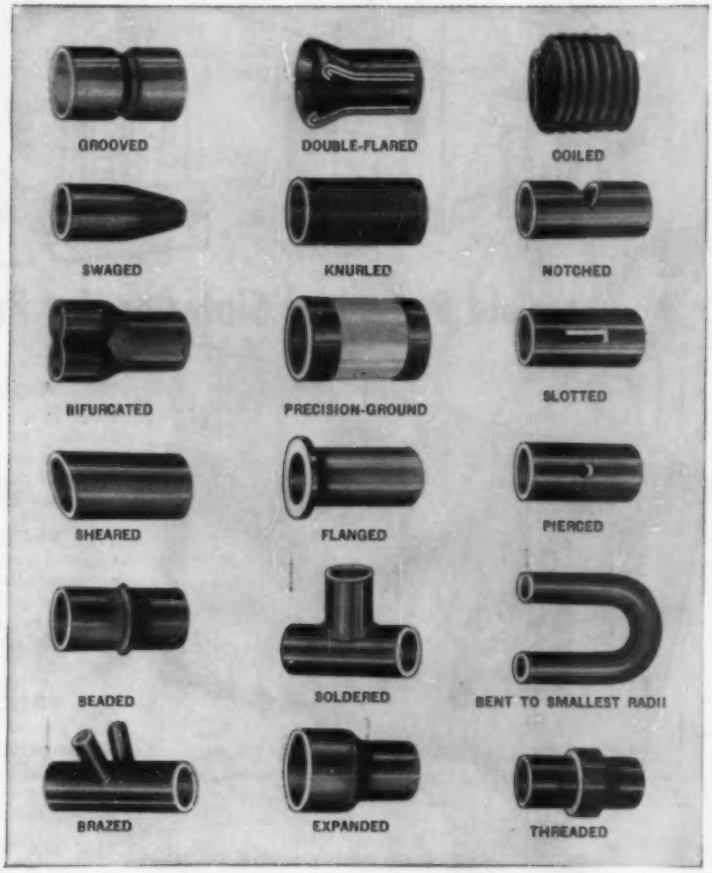
Check first with Bundy for workable solutions to your tubing design problems. Whether you are in the design, developmental, or application stage of your product, Bundy will be glad to work with you. Hundreds of manufacturers have used this Bundy service to advantage.

Bundyweld Tubing offers an unusual combination of properties: high thermal conductivity; high bursting strength; ease of fabrication; and thinner-walled, yet stronger composition. It is the safety standard of the refrigeration industry, and is used in 95% of today's cars, in an average of 20 applications each.

Call, write, or wire us today!

BUNDY TUBING COMPANY

DETROIT 14, MICHIGAN



Shown above are but a few of the fabrication operations which are possible with Bundyweld Steel Tubing. Many of these, and others not shown, were developed through solving a specific problem brought to us by a customer or prospect. Bundy invites you to avail yourself of this design service.

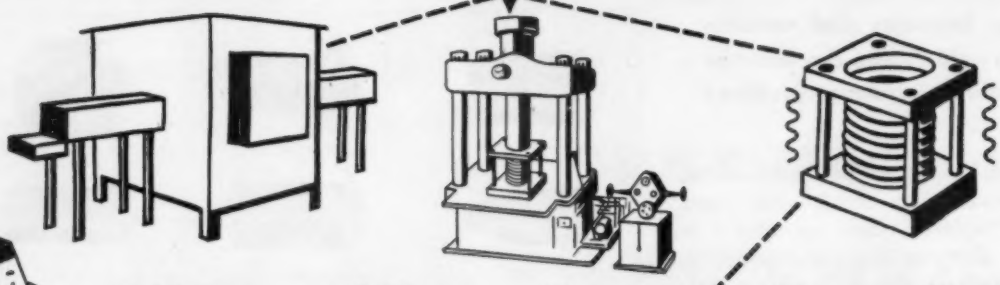
WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, ENGLAND, FRANCE, ITALY, AND GERMANY

Bundyweld starts as a single strip of copper-coated steel. Then it's
. . . continuously rolled twice around laterally into a tube of uniform thickness and passed
through a furnace. Copper coating fuses with steel. Result . . .
SIZES UP TO ¼" O.D.
Bundyweld, double-walled and brazed through 360° of wall contact.

NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

BUNDYWELD TUBING®

DOUBLE-WALLED FROM A SINGLE STRIP



Cold Press and Sinter or Hot Press or Vacuum Sinter!

25 Years of Powder Metallurgy EXPERIENCE FOR SALE!

THE PROBLEM — Industry and Government are engaged today in a gigantic effort to develop new alloys and stronger metals. The future security of America depends on the success of this program. Powder metallurgy, possessing unique advantages not common with any other process, can solve many of the tough metallurgical problems created by the jet age.

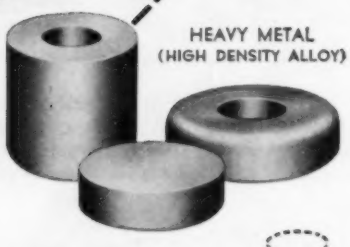
THE FACILITY — Metal Carbides, a pioneer in powder metallurgy, is well qualified by the experience of the past 25 years to help solve your particular problem. Our modern, well-equipped plants of over 100,000 sq. ft. are at your disposal, manned by skilled technicians and metallurgists capable of performing every technique known to powder metallurgy. Here are the facts:

THE PROCESS — Our equipment is varied and complete. Cold pressed and sintered parts can be processed in a vacuum or controlled atmosphere. Hot pressed parts can be produced up to 30" in diameter, up to 100" in length, and up to 5000 lbs. Other available processes include vacuum casting, centrifugal casting, hot forging and vacuum impregnation.

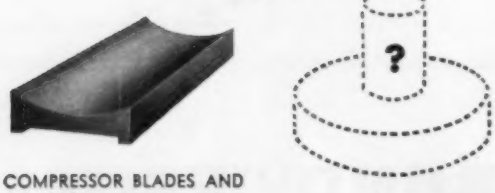
THE MATERIAL — Our experience covers the processing of carbides of tungsten, titanium, tantalum, molybdenum, chromium and columbium. Extensive experiments have also been conducted with various borides, silicides and oxides. Combinations of metals and ceramics have been developed which show great promise, and new possibilities seem unlimited.

THE ANSWER — Metal Carbides has found that by combining the best features of the above processes — with the right combination of metals and materials — totally new advantages result. Whether you require a structure that is porous, dense or tough — or a material that will withstand heat, corrosion or shock — let us put our experience to work helping you reach your objective! **Metal Carbides Corporation, Youngstown 7, Ohio.**

Send for new 84-page Catalog No. 55-G.



HEAVY METAL
(HIGH DENSITY ALLOY)



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WIRE, WRITE or PHONE particulars of your problem or objective and we will advise promptly what our Powder Metallurgy technique can do for you.

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KING-SEELEY CORPORATION

ANN ARBOR, MICHIGAN

HOFFMAN'S ENGINEERED SYSTEMS designed to do the tough jobs in industry

STRIKING ADVANCE IN MATERIALS CONVEYING WILL BRING NEW EFFICIENCY, SPEED, SAFETY TO YOUR OPERATIONS!

Things are moving in the materials handling field. Especially since the development of the double-damper valve. This valve already has multiple applications, and fresh ones are being discovered all the time. Some plants use the valve to feed dry materials *into* a conveying system; in other plants it discharges materials *from* a system. All materials passing through the valve are delivered in uniform, measured batches.

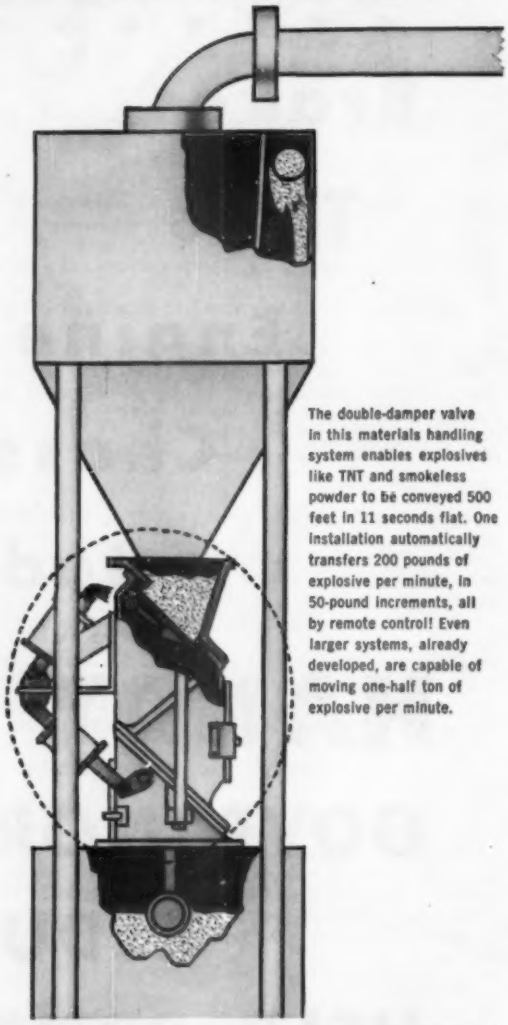
Air appliance engineers had been striving for years to perfect a valve of this kind, which would constitute an effective air-lock between the high-pressure differential inside a pneumatic conveying system and the atmospheric pressure outside. Now they have succeeded. And the number of purposes to which the valve can be put in industrial conveying is enormous.

The double-damper valve represents a new concept in fast, accurate, *safe* conveying. It is now possible—in fact, simple — to move materials that are explosive, fire-hazards or a menace to health, as well as inert materials, because there is no concentration of material and the valve's live rubber seats avoid friction and wear.

The double-damper valve is part of a Hoffman engineered system, another instance of how Hoffman's ingenuity is helping industry achieve the higher standards of safety and efficiency that mean higher output.

Yes, things are moving in the materials handling field, and Hoffman's engineered systems are moving them! Would a materials conveying system speed up your operations . . . make your plant set-up safer . . . increase your capacity?

If you think so, or even if you're not sure, write or call Hoffman, and learn how we are prepared to make your problems our responsibility.



The double-damper valve in this materials handling system enables explosives like TNT and smokeless powder to be conveyed 500 feet in 11 seconds flat. One installation automatically transfers 200 pounds of explosive per minute, in 50-pound increments, all by remote control! Even larger systems, already developed, are capable of moving one-half ton of explosive per minute.

U.S. HOFFMAN MACHINERY CORP.
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Machine tool coolant clarifiers—flotation, mechanical and magnetic
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Multistage centrifugal blowers and exhausters
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NUCLEAR EQUIPMENT DIVISION

Special pneumatic conveying systems
High-efficiency centrifugal separators
Stationary and portable vacuum-cleaning equipment
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Pneumatic systems for radioactive materials

HYDRECO Gear-Type Hydraulic Pump

DUDCO Vane Type Double Pump with Valve Panel

In Your Search for MORE...MORE...MORE—Look to FLUID POWER

More pieces per hour, greater precision, more functions from equipment, more goods to more people faster... these are the areas wherein Fluid Power performs today's miracles in production and distribution. Engineers in The New York Air Brake Company are singularly well equipped with "know-how" and experience to answer YOUR problems.

DUDCO Dual-Vane Hydraulic Pumps and Motors, HYDRECO Gear-type Hydraulic Pumps and Motors, Control Valves and Cylinders run the gamut of Industrial and Mobile Equipment applications... for machine tools; lift trucks; farm and construction equipment; conveyors; oil well, mining or lumbering machinery; for operating winches, cargo booms, hatch covers or steering ships. Name a function on land or sea requiring push, pull, press, raise, lower or rotary motion, and the names DUDCO and HYDRECO are your answer.

In the air—STRATOPOWER Hydraulic Pumps combine amazing weight/horsepower ratios with equally amazing ability to perform dependably at all altitudes and high temperatures.

In Liquid Handling, AURORA Centrifugal and Turbine-type Pumps and KINNEY Heliquad and Rotating Plunger Pumps provide the practical and economical means for moving "anything that will flow through a pipe," from gasoline to asphalt.

KINNEY High Vacuum Pumps, producing pressures down to 0.0001 mm Hg., afford still another important tool to make things better, faster and at lower cost. High vacuum is *the* new technique in many industries.

What are your "MORE" PROBLEMS? Are you fully aware of what The New York Air Brake Company can do to help you solve them?

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HYDRECO Gear-Type Hydraulic Pumps, 3 to 120 gpm; Fluid Motors, 3 to 52 hp; Cylinders; Control and Auxiliary Valves; 1500 psi. DUDCO Dual-Vane Hydraulic Pumps, 3 to 120 gpm; Fluid Motors, 7 to 140 hp; 2000 psi operation.

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Railroad air brake equipment of all types, STRATOPOWER Hydraulic Pumps for Aircraft, to 3000 psi.

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Liquid Handling Pumps, Centrifugals and deep well Turbines, 7000 gpm, 500 ft. heads. Turbine-type, 150 gpm, 600 ft. heads. Condensate Return Units.

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Rotating Plunger and Heliquad Liquid Handling Pumps, to 3000 gpm. Vacuum Pumps, 0.2 micron, evacuate 1800 cfm.

Complete your file of data on new developments in Hydraulic, Liquid Handling and Vacuum Equipment. Write for catalogs today.

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Every step in the development of a missile requires critical precision, and not the least important step is the final act of recording the actual flight on film. For such valuable data, the Fonda Corporation has perfected a new method of film processing which guarantees the utmost safety.

Fonda's New Dynamic Drive* features a revolutionary top tendency drive where tension is so slight that even previously damaged film may be processed without further risk. This, and Fonda's revolutionary new Flexible Building Block System are to be found in the Portable Field Model and in our custom-designed Permanent-Professional installations.

Our skilled engineering staff invites you to use its experience in planning a film processing laboratory designed to suit your own exacting requirements. For further details and brochure, please write to Department TF.

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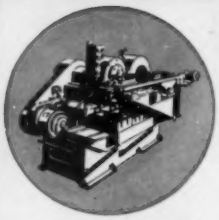
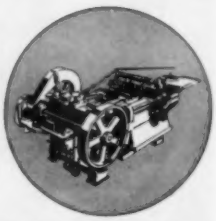
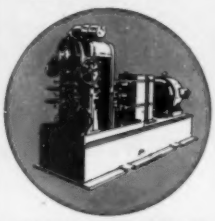
FIVE KINDS OF MASS PRODUCTION METALWORKING MACHINERY by Waterbury Farrel



COLD PROCESS BOLT & NUT MACHINERY —Headers (all types) • Rivet Machinery Trimmers • Thread Rolling Machines Slotters • Nut Formers and Tappers, etc.

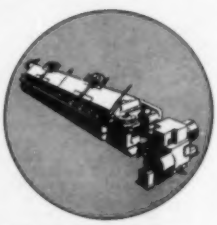
POWER PRESSES — Crank, Cam and Toggle; also Rack and Pinion Presses • Eyelet Machines • Multiple Plunger Presses • Horizontal and Hydraulic Presses, etc.

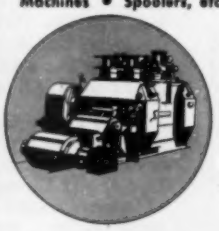




MILL MACHINERY — Rolling Mills: Strip, Rod, Tube, Wire Flattening, (For Ferrous and Non Ferrous Metals) • Also Slitters • Straighteners • Cut-off Saws • Coilers • Winders, etc.

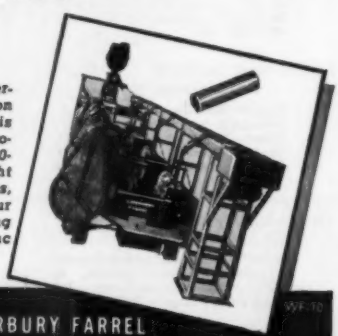
WIRE MILL EQUIPMENT — Continuous Wire Drawing Machines (Upright Cone and Tandem) • Wire Flattening Mills • Chain Draw Benches • Pointers • Swagers • Bull Blocks • String-up Machines • Spoolers, etc.





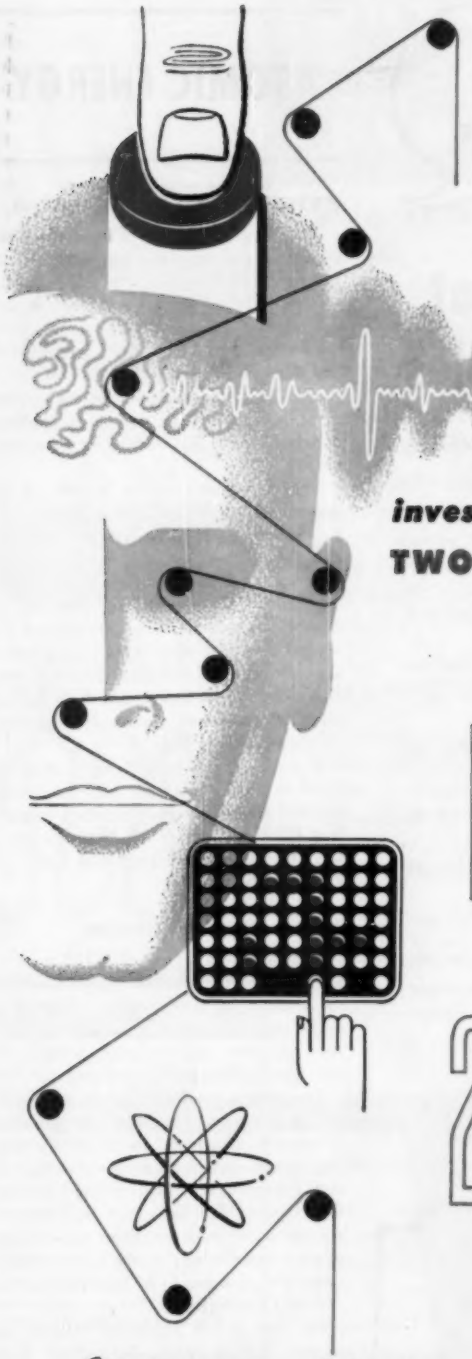
SPECIAL MACHINERY — Sendzimir Mills • Small Arm Ammunition Machines • Thread Rolling Machines For Shells • Collapsible Tube Machines • Coining Mills, etc.

HERE'S A SAMPLE of Waterbury-Farrel mass production equipment in action. This complete WF automatic production unit combines a 40-ton double-acting, upright blanking and cupping press, a conveyor feed and four 7-station horizontal drawing presses to draw 340 zinc shells per minute.



WF-10

WATERBURY FARREL FOUNDRY & MACHINE CO.
WATERBURY, CONN.
Offices: Chicago, Cleveland and Millburn, N. J.



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Complete service includes planning step-by-step sequence of operations and the individual engineering of processes, methods and equipment to meet your production needs. Barnes' creative engineering, developed over a period of 80 years in designing and building high production machine tools, can be depended upon to provide you with the latest in cost-cutting methods. Our highly versatile engineering staff will work with you as a team to solve problems quickly and efficiently.

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To meet specific work-handling or processing needs, Barnes' engineers have designed and built special conveyors, turn-over mechanisms, inspection, and assembling equipment to suit either automatic or semi-automatic requirements. Hundreds of units are today profitably serving a wide range of industries. Because electrical, hydraulic, mechanical, tool and fixture engineering is closely coordinated at Barnes under one roof, you save time and eliminate divided responsibility.

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Find out today why more and more production executives are turning to Barnes for help with their automation problems. Barnes' creative engineering staff will be pleased to analyze your requirements, offer recommendations, and provide you with a cost estimate in a formal proposal, if you desire.

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Builders of Better Machines and Equipment since 1872

W. F. & JOHN BARNES

AUTOMATION SECTION

435 S. WATER ST. • ROCKFORD, ILLINOIS

SPECIAL MULTIPLE SPINDLE MACHINE TOOLS • SPECIAL PROCESS EQUIPMENT • SPECIAL ELECTRICAL CONTROLS

NEW OAKITE CLEANERS
GIVE YOU MORE FOR YOUR
PAINT-PREPARATION DOLLAR

Here are 4 ways to end pre-paint metal-cleaning troubles

Does your trouble chart show that you need better cleaners, strippers or surface conditioners?

- ☐ Cleaning solution foams excessively in spray washing machine. See 1 below.
- ☐ Streaky discolorations or powdery residues cling to surface of steel parts being stripped for repainting. See 2.
- ☐ Zinc phosphating process too difficult to control . . . Iron phosphating process doesn't show good results in salt spray tests. See 3.
- ☐ Too many operations—cleaning, pickling, neutralizing, etc.—are needed to prepare steel that does not require phosphating before painting. See 4.

Here are brief descriptions of new Oakite materials designed to end these particular troubles:

1. For a spray washing solution that does not foam at high pressure, try Oakite Composition No. 161. Does not attack aluminum.
2. For stripping pigmented paint, phosphate coatings and undercoat rust *in one operation*, try Oakite Rustripper.
3. For a zinc phosphating process that is truly easy to control, try new Oakite CrysCoat SW . . . For salt spray results far beyond the capacity of ordinary phosphating processes, try new Oakite CrysCoat No. 89.
4. For *one-operation* removal of rust, heat scale, welding residues and light soil together with good preparation for painting, try Oakite Compound No. 131. Inhibited against attack on steel.

FREE Check the coupon and we will send you free booklets or bulletins with full information on new Oakite cleaners.

OAKITE PRODUCTS, INC.
14F Rector Street, New York 6, N. Y.

Send me free booklets or bulletins giving complete information on the new Oakite materials checked below:

- ☐ Oakite Composition No. 161
- ☐ Oakite Rustripper
- ☐ Oakite CrysCoat SW
- ☐ Oakite CrysCoat No. 89
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NAME_____

COMPANY_____

ADDRESS_____

ATOMIC ENERGY

EXPERIMENTAL REACTOR

The Atomic Energy Commission has signed a contract with Atomics International, a division of North American Aviation, Inc., for the construction and operation of an organic moderated reactor experiment (OMRE) to be conducted at the National Reactor Testing Station in Idaho. The estimated cost of the experiment is $1.8 million, of which approximately $750,000 will be borne by the company.

The experiment, which is part of the Commission's civilian power reactor development program, is designed to establish the technical feasibility of using the hydrocarbon diphenyl as reactor moderating and cooling material. The use of organic compounds such as diphenyl has several potential advantages among which are low induced radioactivity, low corrosion of fuel elements, and high boiling point which makes reasonably high temperature systems possible.

The reactor will be designed to generate 5,000 to 15,000 kilowatts of heat. It will use fuel elements highly enriched in uranium 235. Construction will begin this year, and the reactor is expected to begin operating early in 1957.

DATA DECLASSIFIED

Completion of review of 30,773 research and development reports and informal memoranda in a stepped-up program to make more information available to private industry was reported recently by the Atomic Energy Commission.

The review work—aimed at declassifying or downgrading a large accumulation of reports of potential use in the developing atomic energy industry—was done at the Commission's Oak Ridge (Tenn.) Operations Office by a team of thirty-five scientists and engineers from major Commission installations in the United States under the supervision of the AEC's Division of Classification.

Of the 30,773 classified reports reviewed, 10,916 were declassified, 8,574 were labeled "confidential," and 11,283 remained in the "secret" classification. These reports originated in the Commission's own installations and in laboratories working under contract with the Commission.

Declassified reports go into the open scientific literature and are available without restriction to all who wish them. Classified reports are available, in accordance with the Commission's regula-

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Atomic Energy (Contd.)

tion for access to restricted data, to persons and firms holding access permits.

Except for 5,700 of these reports withheld because of their primary relationship to military propulsion reactors or weapons, all the documents will be made available either to access permit holders or, in the case of declassified documents, to the public generally. Reports having the highest potential use in the private atomic-energy industry will be printed in full-size copy. Others of more limited use will be reproduced in the form of photostats or microcopy.

All are being listed as rapidly as possible in "Report Announcement Bulletins" issued by the Commission at Oak Ridge.

In announcing completion of the special review project, the Commission said that further revision of the Declassification Guide—the document which sets up the rules for classification of information—is under staff consideration for later submission to the Commission.

PARTICLE ACCELERATORS

The AEC has approved the construction of two high-energy particle accelerators —one of which will be a joint Harvard University-Massachusetts Institute of Technology project located at Harvard and the other a joint Princeton University-University of Pennsylvania project located at Princeton.

The Harvard-M.I.T. accelerator will be a 6 billion electron volt machine, with an estimated cost to the Government of $6,500,000. The Princeton-Pennsylvania machine will have an energy of 3 billion electron volts and will be built at an estimated cost of $5,800,000.

The machines will be used for basic research in high-energy physics—a field of investigation fundamental to the understanding of nuclear structure and forces. It is proposed that the machines be made available for research by scientists from other institutions, in addition to the four participating universities.

The Harvard-M.I.T. machine will be a circular alternating-gradient electron synchrotron, with a 118-foot radius. It will be constructed in about 3½ years on a site adjacent to the Harvard Cyclotron Laboratory.

The Princeton-Pennsylvania accelerator will be a uniform-gradient proton synchrotron, to be completed in about 3⅔ years at the Forrestal Research Center. It will resemble the cosmotron at Brookhaven National Laboratory.

AIR FORCE REACTOR

The Air Research and Development Command plans to construct a nuclear reactor facility at Wright Air Development Center, Dayton, Ohio. The 10-megawatt facility, to be known as the Air Force Nuclear Engineering Test Facility,

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Atomic Energy (Contd.)

will be used to test aircraft materials, components, and systems under development for the Air Force's nuclear-powered aircraft. Completion of the $7,500,000 installation is expected by January 1958.

The central feature of the facility will be a uniquely designed water-moderated and water-cooled reactor of a type similar to the Materials Testing Reactor now in use by the Atomic Energy Commission at Idaho Falls, Idaho. It will incorporate two large irradiation test cells, a "swimming-pool" type bulk shielding facility, a spent-fuel storage well, and a number of conventional nuclear reactor facilities.

The "swimming pool," similar to that at the Oak Ridge National Laboratory, will contain 125,000 gallons of water. The entire reactor complex will be housed in a specially designed gas-tight domed cylindrical containment shell of heavy steel which will be set partly below grade in a heavy gas-tight and water-proof foundation to ensure containment of all radioactivity and radiation which could conceivably arise in the remote event of accident or failure of any part of the system.

General Power said that the new facility will meet all safety requirements established by the Advisory Committee on Reactor Safeguards of the Atomic Energy Commission, and its operation will be required to conform to all health and safety rules of the Atomic Energy Commission, the Air Force, and the State of Ohio. All radioactive waste material from the facility will be treated and packaged at WADC before being shipped to remote AEC "burial grounds" for disposal.

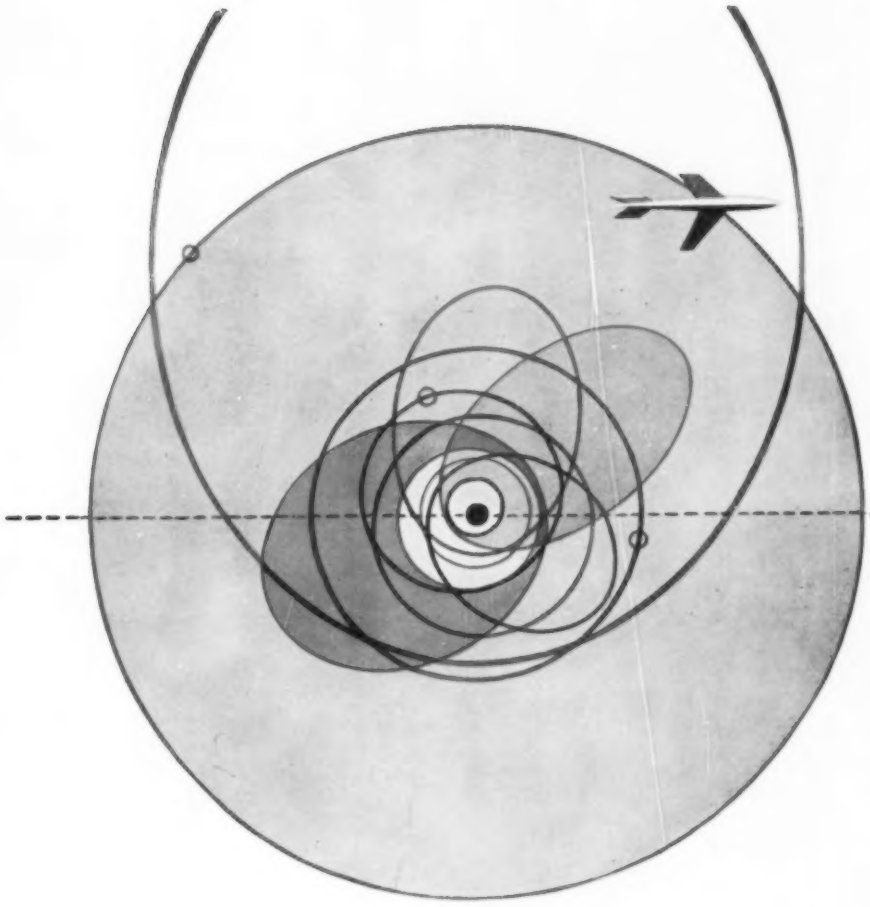
NUCLEAR POWER PLANTS

Permits for the construction of power reactors—the first permits for the private construction of large-scale nuclear power plants—have been issued to Consolidated Edison Company of New York and Commonwealth Edison Company, Chicago. The permits authorize construction by these firms of nuclear power reactors designed to demonstrate the value of the facilities for commercial purposes.

Each construction permit allocates special nuclear material to be made available over a 40-year period for use as reactor fuel. The amounts calculated for the period are: for Consolidated, 5,699 kilograms of U-235; for Commonwealth, 8,323 kilogram of U-235.

Consolidated Edison plans a $55,000,000 power plant, exclusive of cost of land and transmission facilities, using nuclear and conventional fuels in combination to generate 236,000 kilowatts of electricity.

The Commonwealth Edison plant is estimated to cost $45,000,000, exclusive of the cost of land and transmission facilities. The plant will have a net generating capacity of 180,000 kilowatts.



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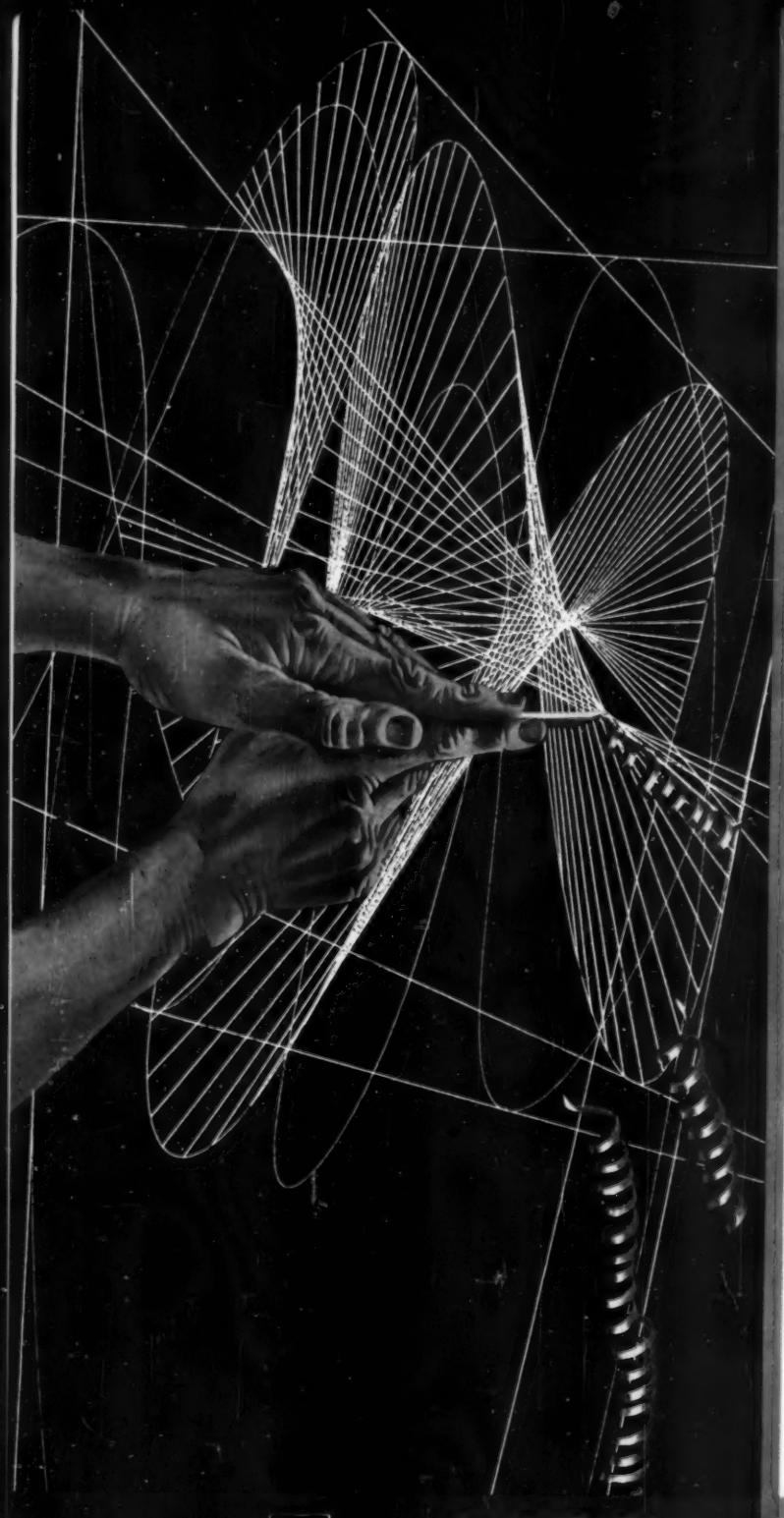

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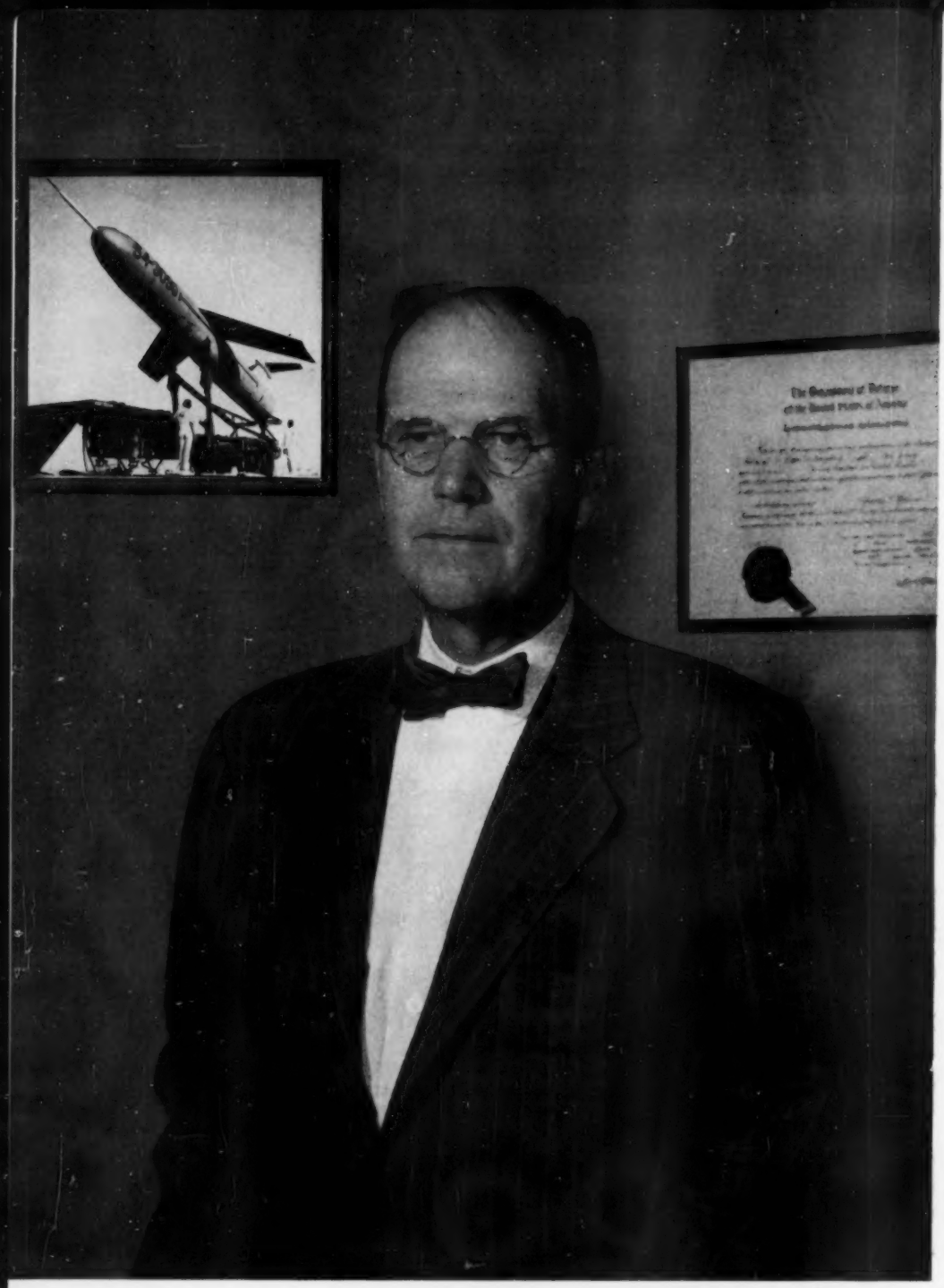


EGER V. MURPHREE

Special Assistant to the Secretary of Defense for Guided Missiles

The Guided Missile Era

Problems in developing the new weapons are now in process of solution

THE advent of the guided missile has challenged the tranquil existence of the Department of Defense. The integration of the Army, Navy, and Air Force under a single Cabinet member was decided upon at a time—not ten years ago—when military activities in the United States were relatively dormant, when conventional weapons were believed to be adequate for any future need, and when new concepts of warfare were struggling hopelessly for recognition in a world which was very tired of martial things.

But rocket and missile development awakened our several military services to the need for an immediate reëvaluation of those things which each service had considered its sole province.

The Army now foresaw its artillery outmoded and its infantry decimated by supersonic, unmanned weapons. It heard rumblings of future push-button wars lasting but a few minutes.

The Navy foresaw the decline of surface ships, and the relegation of its future activities to logistical matters, with some hope that it might be bailed out of seeming oblivion by its air arm.

BUT the Air Force foresaw the attainment of a superior position, one which it had always advocated but as the youngest service in competition with two very strong, older services, had never attained. It reasoned that unmanned aircraft and missiles were an Air Force responsibility and that therefore the Air Force should assume the dominant rôle in the defense function of the Nation.

Thus the interservice battle raged. The fight for superiority and position became a struggle for existence, or so it was made to appear.

The eager press devoted columns to these internecine squabbles, siding first with one, then another, as public sentiment and political expediency dictated.

The Congress and the Department of Defense simultaneously concluded it was necessary to designate a helmsman for guided-missile production.

Eger Vaughan Murphree was born in Bayonne, N. J., on November 3, 1898. Moving to Louisville, Ky., with his parents in 1906, he later entered the University of Kentucky from which he graduated in 1920 as a bachelor of science, being awarded a degree of master of science in 1921. His photograph appears on the opposite page.

He entered the Massachusetts Institute of Technology in 1922, where he remained until 1924 as an associate in the Laboratory of Applied Science.

An interest in the industrial application of chemical engineering led, in 1924, to a position with Solvay Process Company of Syracuse, N. Y. In 1926, he was named director of its chemical engineering division.

He became director of Jasco, Inc., in 1930. In 1932, he was named director of development and research for the Standard Oil Company of Louisiana.

In 1934, he was elected vice-president and director of Hydro Engineering and Chemical Company. Later in the year he moved to New York as manager of the present Esso Research and Engineering Company, becoming successively vice-president in 1937, executive vice-president in 1946, and president in 1947, which position he held when appointed to the Defense post of Special Assistant for Guided Missiles.

During the Second World War Mr. Murphree was a member of the Office of Scientific Research and Development S-1 Committee, headed by Dr. J. B. Conant. This committee aided in forming the Manhattan Project and in developing the atomic bomb.

In 1950 he received the Perkin Medal for work in applied chemistry and in 1953 won the Industrial Research Institute Award for outstanding work in the organization and direction of research.

The top question then became: Where will he fit in the picture in so far as his authority and responsibility are concerned? Also, will the level of his position in this multilayered missile structure be such that he can be effective in coördinating these complexities? Will he be backed up by the Secretary of Defense and the President, in his decisions, unpalatable as many of them may be?

AS if in answer to these questions, the Secretary of Defense set up four qualifications for the assignment. First, the appointee must be knowledgeable in technology; secondly, have proven administrative ability; thirdly, know how to get along with people; and fourthly, have had experience working for a large organization so that he would not be frustrated by Pentagonitis.

The Secretary established lines of authority and responsibility. The incumbent was expected to speed development of all guided missiles, particularly the Intercontinental Ballistic Missile. He would have broad powers and responsibilities, including the "direction and coördination of research, development, engineering, and production of guided-missile activities."

He would serve as chairman of the Secretary's Ballistic Missiles Committee. He would carry the title of Special Assistant for Guided Missiles and would report directly to the Secretary of Defense.

To find a man of these qualifications, free from political and other entanglements, was not easy, but on March 27, 1956, Eger Vaughan Murphree was appointed to this position to head the technical management of all guided-missile activities.

Retaliation or Defense?

Not only must we maintain offensive power sufficient to inflict devastating punishment on an aggressor but we must be sure that he cannot cripple our industrial or military strength by surprise

Maj. George Fielding Eliot

AMERICANS are accustomed by this time to think of our military policy as having for its principal objective the deterring of the Soviet leaders from resorting to war in order to achieve their aims. Most of us realize that an effective deterrent must be the maintenance of such a level of strength as would enable us to win a war if the men in the Kremlin started one, or at least to deny them any advantage from so doing.

For the most part, therefore, we think in terms of what *we* can do to *them* if they should begin hostilities—the deterrent factor, in our imagination, lying in their understanding of the offensive capabilities of our Strategic Air Command and of the Navy's far-ranging fast carrier task groups.

THIS is not, however, the whole story by any means. We must be sure not only that we have created and are maintaining elements of offensive power sufficient to inflict devastating punishment on any enemy who might begin hostilities against us; we must also be sure that our defensive capabilities are such that no enemy can, by surprise attack, cripple our offensive forces or paralyze our national will to fight.

The possession of such defensive capabilities is an essential element of our program of deterrence. If we do not have the ability to defend the bases of our striking power and the centers of our national life against sudden assault, the deterrent quality of our offensive forces is reduced accordingly—and may prove to be nonexistent.

Major Eliot is military analyst for the Mutual Broadcasting System and military and naval correspondent with General Features Syndicate. He is also a well-known author and a frequent contributor to ORDNANCE *magazine.*

Not long ago, as reported in the pages of ORDNANCE, Secretary of the Air Force Donald A. Quarles observed that the best likelihood of continued world peace was "a condition under which an aggressor will know beyond the shadow of a doubt that we possess the certain capability of destroying him if he should attack."

This is quite true, provided the aggressor's calculations could be kept static at that point. But having recognized the "certain capability," no aggressive thinking is likely to stop there. The next consideration is, can this "certain capability" be knocked out or significantly reduced by surprise attack?

"If the potential aggressor should acquire the capability to launch a destructive atomic attack," Mr. Quarles went on, "we would be no less secure as long as we maintain the power to retaliate decisively. This proposition creates a stalemate through deterrent strength, which I believe is, paradoxically, our best hope of peace."

BUT to be a real stalemate, recognized as such by both sides and therefore truly deterrent in its effect, there must be no means of evading the consequences of aggression.

"Great offensive power," said Field Marshal Lord Montgomery in a speech before the Royal United Service Institution, "is wasted unless it is married to defensive power and can be launched from a secure base. As time passes and the offensive capability between East and West levels out, the advantage will go to that side which has the greater defensive strength, which can protect itself against attack and can survive to strike back."

In these days of high-yield nuclear weapons, there is a limit beyond which comparisons of offensive power are of diminishing importance. Once a potential enemy has reached the minimum level of offensive capabilities which enables him—if he can deliver his weapons to selected targets—to inflict fatal damage to our national life, the fact that we may have weapons which could (again, if delivered) inflict proportion-

ately greater injury to him is of less consequence, as a deterrent, than his estimate of our ability to sustain his initial blows and still hit back.

HIS calculations will tend more and more to center on one point: Can he, by surprise, so reduce our offensive power that he can absorb what remains and go on, with an ever-increasing ratio of advantage, to victory? There can hardly be any argument with the assertion that once a commanding initial advantage is gained in a war fought with the weapons even now available, much less those of the foreseeable future, there can be no recovery for the side which sustains disproportionate damage at the outset.

So considered, if deterrence is our objective then it is the primary function of our offensive preparations to establish an element of wholesome fear in the minds of the Communist leaders, and of our defensive preparations to establish a parallel element of equally wholesome doubt. Both have their deterrent value—but the one cannot be expected to deter in the absence of the other.

What, then, are the elements of our defensive requirements? We must begin with two that are fundamental: (1) An effective intelligence system to enable our Government to have a clear insight into enemy capabilities and an understanding of the trends and pressures which may affect his actions; and (2) A sound means of formulating our own policies and reaching the decisions indicated by the facts—within the framework of our constitutional structure and so adapted to the changing conditions of the times as to command the public confidence.

This matter of public confidence is of the first importance and is directly associated with adequate defensive capabilities. In a democracy the armed forces are maintained for the primary purpose of securing the Nation and its vital interests. Unless the people are confident that their safety has been given first consideration in military planning, there will, in days of anxiety, arise strong pressures for increased defenses which may not prove to be militarily desirable.

THE opportunities afforded, in the present cloudy state of public understanding of our military situation, for political exploitation of this factor of public anxiety are great and dangerous.

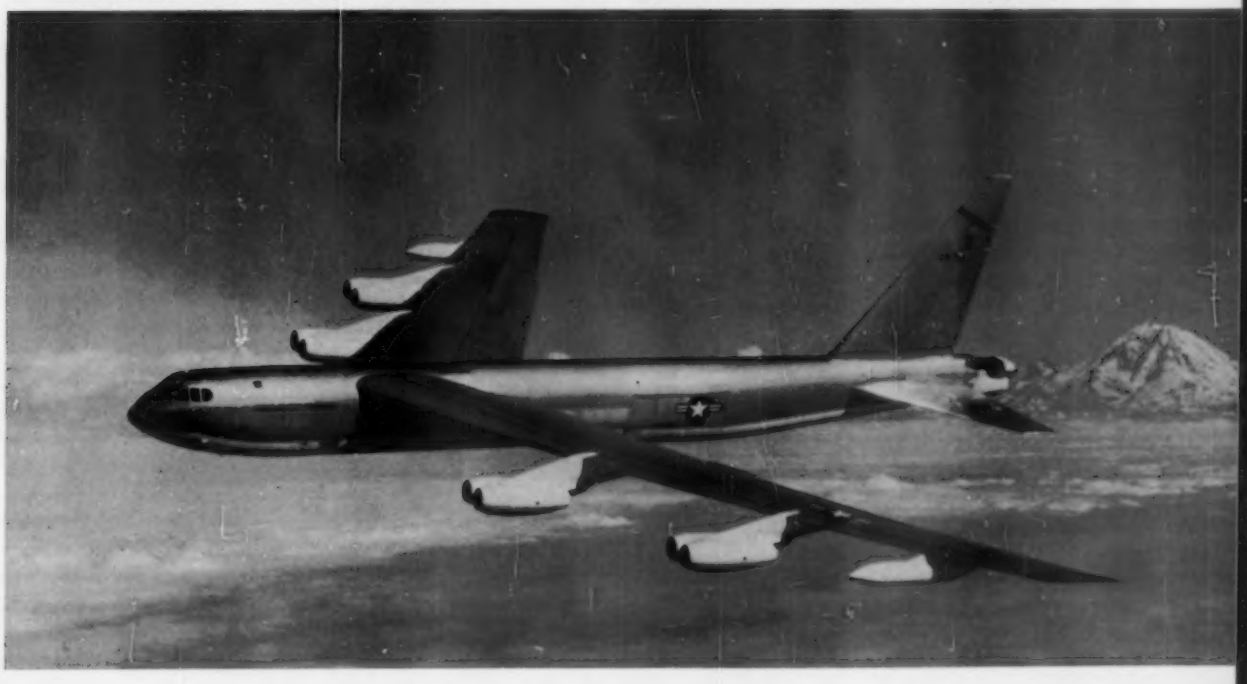
It is not enough that the proportion of our military resources devoted to defense should *in fact* be adequate—it is also necessary that the people should be satisfied that this is so.

Our own history contains several illustrations of the results of failure in this area of public confidence, of which perhaps the most striking is to be found in the year 1862 when General McClellan launched his great amphibious operation against Richmond by way of Chesapeake Bay and the peninsula between the James and York Rivers.

IT was a condition of the Government's assent to his plan that sufficient forces should be left for the defense of Washington, which was in an exposed position. McClellan was, however, so sensitive to what he called political interference with his plans that he did not keep President Lincoln and the Cabinet accurately informed.

A Confederate feint in the Shenandoah Valley—with a force that in fact was far too small to have any chance of successfully attacking the Capital against the troops McClellan had left for its defense—created a panic in the city. The most exaggerated rumors became current, and, as a result, McDowell's

The 8-jet B-52 "Stratofortress" ranks high among the Nation's powerful offensive weapons (Air Force photo).



Corps (which under McClellan's plan was to advance on Richmond from the north and take the Confederate main army in the rear) was retained for the defense of Washington—a fact which contributed very largely to the failure of the whole Union plan of campaign.

A clear understanding between the Army commander and the Government, bolstered by a sound public information service, might very well have resulted in bringing the Civil War to an end in 1862 instead of 1865.

It is all too easy to foresee the dire possibilities in this nuclear age of a loss of public confidence in the adequacy of our defensive arrangements. The lesson of 1862 has its value for present-day policy makers—not forgetting, of course, that President Lincoln's decision was partly due to a faulty intelligence system whose shortcomings were accentuated by McClellan's almost pathological tendency grossly to overestimate the numbers of the opposing forces.

OUR intelligence service today is far superior to that of 1862, but it may be doubted whether our public is even now being taken into the confidence of the Government to the degree necessary to prevent possible distortion of our military plans at a critical moment —or panic which could cost as many lives as enemy action.

As to the operative elements of our defensive power, these include:

1. Early-warning systems, of which the radar outposts in the far north, in allied countries, and at sea and in the air are notable.

2. Communications, by which warning of a coming attack is conveyed to the defensive forces.

3. The interceptor squadrons of the Air Defense Command and the Navy's antisubmarine units guarding our coasts against hostile submarines which today may carry guided missiles with atomic warheads.

4. The Army's Antiaircraft Command, whose guns and defensive guided missiles form the close-in defenses of our industrial cities and other key localities.

"There is a limit beyond which comparisons of offensive power are of diminishing importance. Once a potential enemy has reached the minimum level of offensive capabilities . . . the fact that we may have weapons which could inflict proportionately greater injury to him is of less consequence than his estimate of our ability to sustain his initial blows and still hit back."

5. Internal security forces for the maintenance of order and public security inside the country (these may include Regular, National Guard, Reserve, and State Guard military formations).

6. Civil defense, whose purpose is to mitigate the results of hostile attack or such part of it as has not been intercepted, turned back, or destroyed by the active defense forces.

7. The FBI and other intelligence and police agencies for our protection against spies, saboteurs, and subversive activities.

A serious failure or breakdown in any of the foregoing defensive elements might bring national disaster in wartime and might prove the decisive weight in the scales of hostile decision when judging the risk of attack on this country.

None of them, with the possible exception of the FBI, is in a state of complete readiness today. The military elements listed above are all growing, some faster than others, some well advanced and others just beginning to take effective form.

In most cases what is serviceable today may be outmoded tomorrow—we may not be far from the time when long-range missiles will begin to usurp the present duties of piloted interceptor aircraft. But this is the case with most military devices and techniques in this nuclear age, whether offensive or defensive in their application to the overall problem of national security.

By far the most serious shortcomings among our several defensive agencies is found in civil defense. Despite the devoted service of a comparatively few individuals, there has never been either the degree of public interest or enough appropriated funds to make our civil defense realy effective.

Some who have given serious thought to this failure and its possible consequences believe that—paradoxically—civil defense will not work satisfactorily unless it is taken over by the military arm of the Government; that is, by the Department of Defense, perhaps as a fourth military department.

There is a good deal to be said for this idea. In case of war, or even a serious emergency other than war, there is an inclination to call on the military anyway. Martial law is an established recourse for emergencies when civil control breaks down or lacks the resources to cope with the problem.

The last Congress passed legislation which again permits the States to maintain military forces of their own, aside from the National Guard—whose units must be subject to being sent to whatever theater of operations necessity may require. There are a great many men of military experience in the country who are past the age for active service in the field but whose abilities would be invaluable in organizing and directing civil-defense operations.

Such personnel who are still members of the various Reserve forces might be given mobilization assignments in civil defense and others encouraged to apply for such assignments. Together with the small but enthusiastic group of men and women who have stuck it out with civil defense through years of discouragement, we might thus gather a nucleus of leadership around which could be gathered a sufficient number of volunteer helpers to make civil defense work as it ought to work.

PUTTING the top direction of civil defense under the Defense Department would give this vital activity added prestige and a greater leverage on Congress for the needed appropriations, as well as providing for more effective coördination with the military elements of our defensive setup—not only at the national, but at State and community levels.

Tying in the State and local govern-

ments with such a civil-defense establishment would present many complications, but it is already clear—considering the wide danger-space of modern weapons—that State and municipal boundaries will have little importance in future wars.

The organization of civil defense on a "target area" basis is essential, and for this only a nationwide agency clothed with all necessary authority can make adequate provision.

AS to arousing public interest, even enthusiasm, it is not to be done by the scare method. This has been tried for a long time, with little result. People just don't want to think in terms of what they are going to do if "they" ever drop "that thing" on the old home town.

If it were made abundantly clear by every available medium of public information that a first-class, effective civil defense will help make it less likely that "they" will ever attempt to drop "that thing" on any American community, the American people would be quite likely to give serious heed, and many of them, many more than at present anyway, might take a share in helping make the civil defense program really effective.

For an individual to give up leisure time attending training classes to learn how to be a block warden or an auxiliary fireman—or for the management of an industrial firm to spend large sums of money in providing emergency means such as underground record storage and alternate control organization in order to maintain continuity of management and production for an emergency that may never happen—is a decision that is not readily taken in the absence of constructive persuasion.

A FEW individuals, a few companies, have done so; the majority have not. It's easier to say it can't happen here and if it does there's nothing much to be done about it anyway.

But once it becomes clear that to prevent it from happening here the primary need is to convince potential enemies that it won't pay off (and that every civil-defense volunteer, every firm which goes all out for plant defense and emergency control methods is helping to do that convincing) there can be a great change of attitude.

No doubt that was what President Eisenhower was thinking of when he told his news conference on March 15, 1956, "The more effective our civil defense, the greater is the deterrent power of this country against the outbreak of any war."

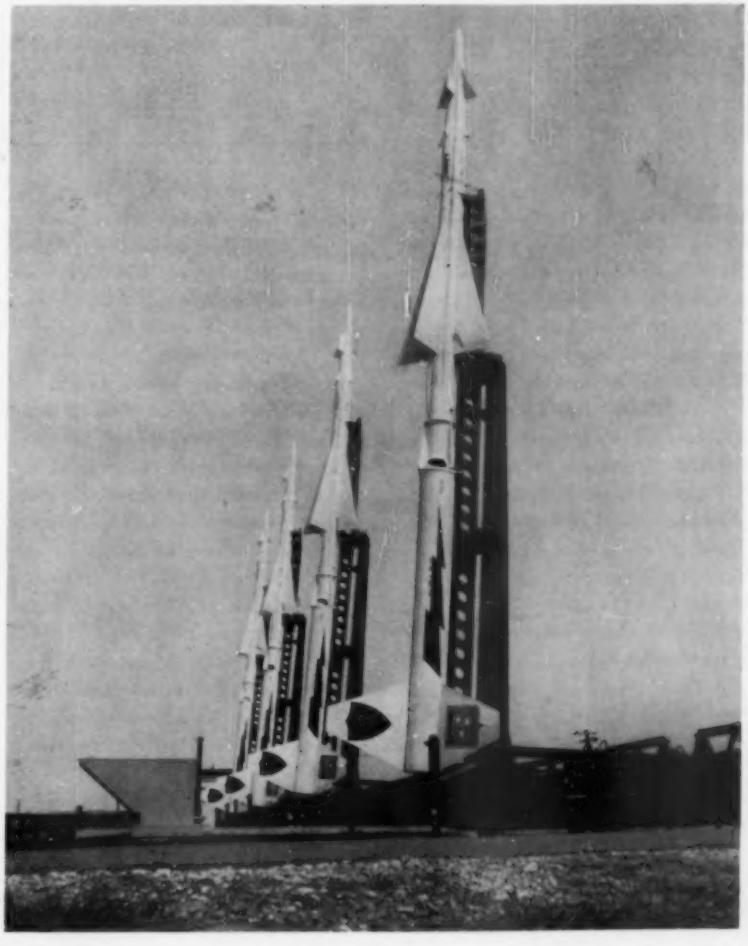
The President's words were strongly supported by Otto L. Nelson, Jr., director of the East River Civil Defense study project, who told a congressional committee:

"A strong, effective civil defense could become the critical, determining factor that might persuade the Soviets, even in a period of great rashness and madness, that they should not risk an atomic war."

We all need to do a little rethinking and to get rid of some of the clichés and slogans that leap too readily into our minds when the subject of national security is under discussion. "Massive retaliation" is all very well, and without the power of massive retaliation we should be in peril indeed; but massive retaliation can be effectively launched only from a secure base. If its base is vulnerable, it may fall fatally short of being massive.

OUR "first line of defense" is not on the Rhine, nor along the Arctic radar outposts—it is in the minds of the men in the Kremlin. If ever they are tempted to take the risk of war, a vital part of their weighing of that risk will be their estimate of our ability to absorb their initial blows and keep on striking blows of our own.

Batteries of "Nike" guided missiles strategically emplaced and ready to fire are an important part of our defensive capabilities (Army photo).



Fallout from the A-Bomb

Although debris falling within a hundred miles af a nuclear explosion constitutes a real hazard, the major part of radioactivity from a high-yield weapon is dissipated negligibly in the stratosphere

Dr. Willard F. Libby

THE radioactive debris which falls out of the atmosphere after the explosion of a nuclear weapon is called the radioactive fallout. As generally understood, this term pertains to the sum total of all the radioactive materials which reach the surface of the earth, regardless of their origin.

Some of the present confusion which exists regarding the hazard from fallout can be clarified by recognizing that the radioactive debris comes from two main sources (1) the radioactive products which depend directly on the nature of the weapon and whether it is one of low or high yield, and (2) the radioactivity induced in the environment, which depends largely on whether the weapon is fired in the air, near the ground, or under the sea.

Various combinations are possible, each with a corresponding degree of fallout hazard both on a short-term and a long-term basis.

In the weapon test operations great care is taken to ensure that no persons are exposed to danger from local fallout. Criteria are used which are meant to ensure that this be so. However, it is well to note that it is only from such test operations that we have learned what we do know about civilian defense against fallout.

While the area of local damage is larger for a high-yield weapon than for one of lower yield, it can be shown that the long-term effects of fallout from the high-yield weapon are not as great as are generally supposed. This is the main point I wish to present. It is a summary of a worldwide Commission investigation known as Project Sunshine.

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In the ordinary atomic bomb, for example, for each 20,000 tons of TNT equivalent of explosive energy about 2 pounds of radioactive materials are produced from the bomb itself. In these two pounds are some ninety different radioactive species varying in lifetime from a fraction of a second to many years.

One of the most important of these is strontium 90, a bone-seeker with a half life of 27.7 years, comprising approximately 5 per cent of the fission products produced. This mixture of radioactivity decreases in intensity in such a way that for every sevenfold increase in age the total radioactivity is decreased tenfold.

Thus seven hours after the explosion the radioactivity has decreased to one-tenth the radioactivity at one hour, and in 49 hours to 1/100, and at 2 weeks to 1/1000, and in three months to 1/10,000 and so forth.

All nuclear weapons involve large numbers of neutrons, and we should consider the possible effects of neutrons which to some degree escape out of any weapon and make the environment radioactive. In the case of air bursts, the question is: What do neutrons do to air? The answer is simple: They make radioactive carbon, C-14, with a half-life of 5,600 years.

Fortunately, this radioactivity is essentially nonhazardous because of the low energy of its radiation and the enormous amount of diluting carbon dioxide in the atmosphere.

THE cosmic rays themselves generate neutrons, which, of course, produce radiocarbon. The earth has on its surface in the biosphere, hydrosphere, atmosphere, and lithosphere a total of some eighty tons of radiocarbon from the cosmic radiation. Since each neutron forms one C-14 atom, this corresponds to 5.7 tons of neutrons, and we see that this enormous number of neutrons would have to be produced and escape in order that nuclear weapons would just double the natural radioactivity of living matter due to radiocarbon.

Such an increase would have no sig-

nificance from the standpoint of health. The atmosphere itself contains only 1½ per cent of the total carbon with which the cosmic-ray-produced radiocarbon is diluted, so we expect that nuclear weapons could produce a short-range rise in the radiocarbon content of the carbon dioxide in the atmosphere, which later would decrease as the atmospheric carbon dioxide mixed with the sea.

Therefore only 1½ per cent as many neutrons would be required to double the natural radiocarbon content of atmospheric carbon dioxide for this time before mixing with the sea could occur, or about 78 kilograms of neutrons.

To orient ourselves, an atomic weapon with a TNT equivalent of 20,000 tons involves the fission of, let us say, one kilogram of uranium or plutonium and the liberation of about ten grams of neutrons. If all these neutrons escaped into the atmosphere it would obviously require 7,800 such weapons to double the radiocarbon content of the atmospheric carbon dioxide even with no mixing with the sea, and about 520,000 with complete mixing.

These correspond to explosive energies of 156 and 10,400 megatons of TNT, respectively, if all neutrons formed escaped. A reasonable escape figure might be 20 per cent, so we can expect that nearly 800 megatons of fission would be necessary just to double the atmospheric radiocarbon content and that about 52,000 megatons would be necessary for the same effect on a long-term basis.

The interchange between the atmosphere and the sea water, which is constantly taking place, would deplete and remove the excess radioactive carbon dioxide. It is known from measurements of radioactive hydrogen-tritium—which also is made in the atmosphere by the cosmic rays—that this interchange is slow.

WE learn that the radioactive water which is formed by the burning of the tritium made by the cosmic rays is not diluted by more than the top one hundred meters or so of sea water in its average lifetime of about eighteen years.

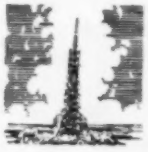
In other words, a dilution by more than the twofold which corresponds to the dissolved carbon dioxide and carbonate and bicarbonate in the top one hundred meters of ocean water would take longer than eighteen years. The dilution by this factor of two, however, would occur essentially within a matter of weeks or months.

Therefore we would have to double our estimates for even the short time scale activation of the atmosphere to reach the enormous figure of approximately 2,000 megatons of fission required.

Thermonuclear weapons, of course, also involve neutrons. For a given energy release they produce somewhat more neutrons than a pure fission weapon; however, the order of magnitude of atmospheric activation would not be greatly different. So our estimates apply to all nuclear weapons.

The essential point is that the atmosphere is difficult to activate and the activities produced are benign. In addition to carbon 14, there are a few others produced in low yield, including tritium and very short lived products, but none is produced in sufficient amounts to be hazardous.

A bomb fired on the surface of the earth, however, may have an appreciable portion of its radioactivity reprecipitated within relatively short distances, while bombs fired beneath the sea may place essentially no fallout radioactivity in the atmosphere.



Therefore the question of the area of induced contamination to be expected from nuclear weapons cannot be answered categorically without specifying the degree of contact of the fireball with the surface of the earth and probably also specifying the characteristics of this surface.

Obviously water would differ considerably from soil in its ability to precipitate radioactive fallout. The coral in the Eniwetok islands used for the larger U. S. weapons tests will decompose under great heat to form calcium oxide which will then rehydrate to form calcium hydroxide, which in turn will absorb carbon dioxide to form a crust of calcium carbonate.

Obviously such a complicated series of chemical reactions will make the fallout particles from the great tests at Eniwetok differ from what would be observed if the same weapons had been fired over ordinary sand or granite rock.

From the standpoint of the *rate* of fallout there are essentially two classes of nuclear weapons—the high-yield megaton weapons, and the lower-yield kiloton weapons. All nuclear weapons produce atomic clouds which rise to heights dependent upon the energy released, and the clouds from the megaton class rise into the stratosphere, while the smaller clouds do not.

THE high-yield clouds rise rapidly up through the troposphere and the tropopause, and quickly pass into the uppermost layer of the atmosphere which is called the stratosphere. This part of the atmosphere is essentially isolated from the lower or troposphere layer in which we live, and where all of our normal winds and storms, etc., occur. Therefore, the radioactivity produced in megaton weapons is placed largely and immediately in the stratosphere while the smaller kiloton weapons produce clouds which in general do not reach into the stratosphere but stop near the tropopause—the imaginary boundary between the troposphere and stratosphere—and the bulk of their radioactivity is left in the troposphere.

Let us consider in some detail the mechanism by which this most important fallout radioactivity produced in nuclear weapons might be expected to enter the human body.

In the troposphere where rain occurs, any particulate matter will be washed down in a period of days or weeks. It is easy to show, for example, that one-tenth inch of ordinary rainfall will probably remove almost completely all particulate matter except that which is so small as to be nearly of molecular dimensions.

In other words, for one-tenth of an inch of rainfall one can be quite certain that the atmosphere between the layer in which the rain originates and the ground is washed clean of fallout radioactivity, except for that minute fraction

which may be so small as to move with the air out of the way of the falling raindrops as they make their way toward the earth. Even this tiniest fallout material is likely to be precipitated for it will migrate rapidly by molecular-type motion and in this manner is likely to absorb itself on other particulate material and so be rained out also.

For these reasons, tropospheric radioactive fallout does not stay in the atmosphere for a long period of time. It may make two or three trips around the earth in a given latitude before being entirely removed, but its lifetime in the atmosphere will be a matter of only a few weeks.

This is in very sharp contrast to the material which is placed in the stratosphere by megaton weapons. Our present experience indicates that the fallout from megaton weapons which does not occur essentially in the first few hours or days, and is therefore deposited locally, is subsequently deposited only at a very slow rate corresponding to an average time in the stratosphere of about ten years.

As a result of this long residence time in the highest layers of the atmosphere, the winds mix and distribute the radioactive material broadly over the earth. The rates of deposition are found to depend but little on latitude and longitude and are relatively uniform over the entire earth's surface.

HIGH-YIELD weapons fired near the surface are therefore characterized by three kinds of fallout. The first or local fallout is due mainly to large-sized particles and may cover a considerable area depending on surface winds.

According to the February 15, 1955, press release of the Atomic Energy Commission which describes the Castle test series held in the Marshall Islands during the spring of 1954, some 7,000 square miles were said to be thus contaminated.

The second type of fallout from high-yield weapons is composed of smaller particles which never reach the stratosphere and thus stay in the troposphere until they are carried down by rainfall and settling.

There is thus a band of fallout corresponding to the same general latitude as the test site; the material may circle the earth two or three times before being precipitated but does fall out within the first few weeks.

However, a large part—perhaps half—of the total radioactive materials produced in a high-yield weapon test resides in the stratosphere itself and descends to earth at an average rate of approximately ten per cent a year as described above.

The principal radioactivities produced by the testing of nuclear weapons are from the fission products of the weapons themselves, and not from the environment. Radioactive strontium is the most important of these for several reasons.

First, strontium is chemically similar to calcium, which is one of the main mineral constituents of the body. Bone consists principally of calcium phosphate, and for this reason radiostrontium, like calcium, should be deposited in the bone. The amount of ordinary nonradioactive strontium naturally present is so small that the radioactive strontium will follow ordinary calcium into the body and not differ from it seriously in its chemical behavior.

The second reason that radioactive strontium, Sr-90, is important is that it has a long but finite lifetime—27.7 years half-life, 40 years average life—and thus has a persistent effect.

Thirdly, because of its low rate of turnover it stays in the body a long time, and, fourthly, the probabilities of body ingestion can be high. Finally, the fifth reason for its importance is that Sr-90 is produced in high yield in the fission reaction—about 5 per cent of all fissioning atoms yield this isotope.

In order to orient ourselves, let us consider the maximum permissible concentration for radiostrontium recommended for AEC workers by the National Committee on Radiation Protection—one microcurie for the standard man whose body is assumed to contain a total of 1,000 grams of calcium.

This maximum permissible concentration is, of course, well below any level at which one would expect any damaging effects to appear. On the basis of experiments with animals, statistically observable increases in the number of bone tumors should not be expected to appear at less than ten times this level.

As we go above this figure, the chances for bone tumor occuring increases rapidly so that the likelihood of bone cancer at thirty to forty times the NCRP figure is appreciable.

TWO megatons of fission energy would be equivalent to about one millicurie of strontium 90 per square mile of the earth's surface, or about seventy-nine disintegrations per minute per square foot. The average soil of the earth contains about 20 grams of calcium in a form available for plant metabolism in the top 2½ inches of each square foot of area.

Now returning to the maximum permissible concentration of one microcurie per standard man and assuming that in order that this concentration not be exceeded the topsoil of the earth should not contain any more radiostrontium than would correspond to the concentration in the human body which is just permissible (one microcurie per 1,000 grams of calcium, or 2,200 disintegrations per minute per gram of calcium), we find that 1,100 megatons of fission energy would have to be released to reach this level. Actually, of course, the conditions in the calculation are so idealized that they indicate no more than the proper order of magnitude.

In other words, to maintain a steady-state concentration magnitude of Sr-90 distributed uniformly in the top 2½ inches of the earth's surface and equivalent to the maximum permissible concentration in our standard man, there would be required detonations totaling 1,100 megatons equivalent of TNT plus a further quantity of Sr-90 added at intervals to allow for decay.

This steady-state concentration would be 550 millicuries per square mile. This estimate of 1,100 megatons would be increased appreciably because of two factors: (1) the decay of the radiostrontium in the stratosphere before the Sr-90 reached the earth, and (2) the fact

that there is a metabolic discrimination against the assimilation of Sr-90 compared with calcium, as explained later, of approximately 10 or 15 to 1.

The researches on radiostrontium fallout conducted by the AEC under Project Sunshine have been quite extensive. Measurements of the Sr-90 content of soils, rain and snow, and biological materials on a worldwide basis have shown that Sr-90 fallout occurs all over the world at rates which are not very dissimilar, except that there is a tendency in the middle latitudes in which the tests are conducted for an extra fallout presumably of the tropospheric variety described above.

SINCE the completion of the Castle series of tests in 1954, this worldwide rate of fallout has approximated one and one-half millicuries of radiostrontium per square mile per year. It is interesting to note in this connection that it will be 1961 before half of the radiostrontium introduced into the stratosphere by the Castle Operation will have descended to earth, and 1968 before three-fourths will have come down.

We thus see that radioactive fallout from the stratosphere is a very slow process. This is very fortunate, indeed, because the high-yield weapons thus have much of their radioactivity dissipated in the atmosphere in a harmless way.

Soil samples have been obtained on a worldwide basis by Dr. Lyle T. Alexander of the United States Department of Agriculture, Beltsville, Md. With great skill and care he has analyzed them chemically and submitted them for measurement of radiostrontium content to the Health and Safety Laboratory of the New York Operations Office of the Atomic Energy Commission, the Lamont Geological Observatory of Columbia University, and the Enrico Fermi Institute for Nuclear Studies at the University of Chicago.

On the basis of the information so obtained, it is possible to say unequivocably that nuclear weapons tests as carried out at the present time do not constitute a health hazard to the human population in so far as radiostrontium is concerned, and it is believed with good reason that radiostrontium is likely to be the most important of the radioactivities produced. It is also well to note that because radiostrontium is assimilated in the bones, it constitutes essentially no genetic hazard, because its radiations do not reach the reproductive organs.

"The radioactivity produced in megaton weapons is placed largely and immediately in the stratosphere while the smaller kiloton weapons produce clouds which . . . do not reach into the stratosphere . . . and the bulk of their radioactivity is left in the troposphere. . . . In the troposphere where rain occurs, any particulate matter will be washed down in a period of days or weeks. It is easy to show that one-tenth inch of ordinary rainfall will probably remove almost completely all particulate matter except that which is so small as to be nearly of molecular dimensions."

Milk, cheese, alfalfa, animal meat and bone, and even human bodies have been extensively studied. The radiostrontium content of milk and cheese is not as high, relative to that of the grass which the cows eat, as one might expect.

There appears to be a discrimination against the fallout material such that the calcium in milk and cheese is approximately one-fifth to one-tenth as radioactive with respect to radiostrontium as the grass that the animals eat. There are various possible physiological explanations of this, and the conclusion itself may not be completely certain, but the data available to date indicate it to be true.

In addition, the plant uptake of radiostrontium from soil does discriminate somewhat against radiostrontium as compared with calcium. The calcium taken up from the soil into the plant has in general about one-half the radiostrontium content that the soil calcium has. Since milk and cheese are the principal sources of calcium in the human diet, these two results help to protect the human population against ingestion of radiostrontium compared with calcium by a factor of perhaps 10 or 20 to 1.

We find, therefore, that the radiostrontium content of human bodies is the lowest of all animals measured and is much lower than the average soil and the average foliage.

The ratio of Sr-90 to calcium in young people whose bones are still growing corresponds to about one-thousandth of the maximum permissible concentration currently recommended for adults: one microcurie per standard man containing 1,000 grams of calcium. The average soil in the United States is about tenfold higher, whereas abroad the radiostrontium content in other areas of the world not subject to local test fallout is about one-third of that for the United States. The radiostrontium is absorbed in the top two or three inches of soil and held there very tenaciously.

Plowing, of course, buries it more deeply, but it appears that in unplowed soil the radiostrontium does not move in a matter of two or three years.

The air itself contains radiostrontium due to the fallout from the tropopause and from the stratosphere, and the quantity corresponds to the average time between rainstorms. The rain carries away the radioactivity, but when it runs off to the rivers and the seas it is nearly pure due to the action of the soil in absorbing the fallout.

Rivers are essentially free from radiostrontium. Lakes and reservoirs have a content which corresponds approximately to their surface areas only.

IN summary, though the major part of the radioactivity from high-yield weapons fortunately dissipates in the stratosphere, the small but very significant part which falls out within a few hundred miles of the site of the explosion constitutes a very real hazard. The weapons tests are conducted with great attention to this and other dangers, and every effort is made to protect against misadventure.

What we have learned from the Sunshine studies is that these local precautions should be entirely adequate and that worldwide hazards at the present rate of testing are insignificant.

Civilians in Atomic War

Without a return to the traditional international-law doctrine of immunity of noncombatants from attack, hopes for the limitation of nuclear weapons to tactical purposes only will remain unfulfilled

Neil P. Hurley, S.J.

Mr. Hurley, a member of the faculty of Fordham University, New York City, has published other articles on the vulnerability of American industry to atomic attack. This article is unique in that it stresses the seldom discussed problem of indiscriminate destruction of areas including the noncombatant civilian population.

THE distinction between military forces and innocent civilians is slowly being laid to rest in the same sepulcher with medieval chivalry and the respect for treaties. Still vigorous in World War I, the principle which cast a protective cloak about nonmilitary inhabitants of a warring nation was eroding in the light of modern weapons even before the outbreak of hostilities in World War II. The 1939 revision of America's Industrial Mobilization Plan testified:

"War is no longer simply a battle between armed forces in the field—it is a struggle in which each side strives to bring to bear against the enemy the coordinated power of every individual and of every material resource at its command. The conflict extends from the soldier in the front line to the citizen in the remotest hamlet in the rear."

Because modern war is an all-out effort involving the entire Nation, the time-honored distinction between the combatant and the noncombatant fell into disuse.

The fact that jet aircraft and weapons of unimaginable destructive power have come recently upon the military scene has made it more tempting to fly behind enemy lines and bomb urban areas and major industrial installations. This was verified by the experience of the air forces engaged in World War II.

Obliteration bombing grew to be quite common in the Second World War. By obliteration bombing we mean the strategic bombing, by means of incendiaries, explosives, and nuclear weapons, of industrial centers and heavily populated areas in which the target to be wiped out is not a definite factory, bridge, or similar object but a large section of a whole city, comprising one-third to two-thirds of its whole built-up area and including by design the residential districts of workingmen and their families.

In the early part of World War II the British did not make use of obliteration bombing; *i.e.*, the destruction of a target including a large built-up area of an entire city. However, once the Germans began to horrify the world by bombing civilians in Warsaw and later in Rotterdam, and to bomb British targets indiscriminately, the RAF changed its former policy for one of obliteration bombing.

In World War II, consciences were still tender with regard to the direct bombing of noncombatants. On September 1, 1939, President Roosevelt registered this protest against obliteration bombing in a joint appeal to the German and Polish Governments:

"THE ruthless bombing from the air of civilians in unfortified centers of population during the course of hostilities which have raged in various quarters of the earth in the past few years, which have resulted in the maiming and death of thousands of defenseless women and children, has profoundly shocked the conscience of humanity . . . I am therefore addressing this urgent appeal to every Government which may be engaged in hostilities publicly to affirm its determination that its armed forces shall in no event and under no circumstances undertake bombardment from the air of civilian populations or unfortified cities, upon the understanding that the same rules of warfare will be scrupulously observed by all their exponents" (*London Tablet*, CLXXXIII, May 20, 1944, 243).

Soon after, however, the Allied powers were to resort to area bombings. Brendan Bracken, Minister of Information, in a press release in August 1943,

stated the British policy clearly: "Our plans are to bomb, burn, and ruthlessly destroy in every way available to us the people responsible for creating the war."

The Strategic Bombing Survey for Europe indicates how widespread were "spill-over" and "area" attacks on German cities. These are but other names for obliteration bombings. Even the French complained of the blind bombing which results in "the maximum loss to civilian life with the minimum of strategic achievement" (*The New York Times,* June 4, 1944).

In France the Allied air forces were responsible for the death or injury of men, women, and children who had nothing to do with the war—homes, churches, schools, and hospitals were being indiscriminately destroyed (Cf. *London Tablet,* CLXXXIII, May 20, 1944, 246).

IN England in such cities as Coventry and London not only entire blocks but whole districts were reduced to rubble. Damage from bombing was not unknown in such Belgian cities as Brussels, Ghent, Liége, Maline, and Charleroi. The greater part of this damage was due to the random dropping of high-explosive and incendiary bombs over densely populated communities.

The immunity from direct violence, which all those not bearing arms enjoyed as a prescriptive right under the traditional law of nations, has become more and more attenuated since the First World War.[1] The Bomber Command of the RAF adopted the systematic bombing of German cities in such wise as to spread out the bomb pattern more effectively.

It was thought that the morale of civilians could be affected and that, if laborers could be diverted from the factories to recuperative tasks such as caring for their families and repairing damage to their homes or important plants and facilities, German war production would suffer severely (Cf. "The United States Strategic Bombing Survey, Over-all Report, European War," September 30, 1945, p. 71).

The Strategic Bombing Survey stated the Allied intentions as being fourfold: (1) area raids were to be made at night, thus precluding precision bombing; (2) they were to be directed against large cities; (3) they were designed to spread destruction over a large area rather than to knock out specific plants or installations; and (4) they were intended primarily to destroy morale, particularly that of the industrial worker.

Though it must be admitted that accuracy was far below pin-point bombing because of the presence of heavy flak, enemy fighter attacks, bad weather, and poor visibility, nevertheless it would seem that a greater attempt at "pickle-barrel" bombing might have been made. The extraordinary efforts to avoid bombing the Vatican in World War II would seem to indicate that obliteration bombing of German targets in World War II was intended more often than not.

The Strategic Bombing Survey has defined an "area raid" as a raid intentionally directed against a city area by more than 100 bombers with a bomb weight in excess of 100 tons, which destroyed more than 2 per cent of the residential buildings in the city. (This was different from intended precision raids which miscarried and had the effect of an area raid.)

In such intended "area raids" during the period from October 1939 to May 1945 the Allied air forces, primarily the Royal Air Force, dropped over half a million tons of high explosives, incendiaries, and fragmentation bombs on the 61 German cities having a population of 100,000 or more. These cities included 25,000,000 people, 32 per cent of the Reich's population, and had a labor force of 4,858,900 (Cf. U. S. Strategic Bombing Survey, p. 72). Thus, less than 20 per cent of all the population in these target cities composed the industrial working force.

The Survey reported that all "area attacks" are estimated to have destroyed totally or heavily damaged 3,600,000 dwelling units, accounting for some 20 per cent of Germany's total residential units and rendering some 7,500,000 people homeless. AAF "area raids," directly intended as such, killed about 300,000 and injured some 780,000. In addition to loss of life and limb, over 5 million Germans were forced to evacuate due to obliteration bombing efforts, while from 18 million to 20 million persons were deprived of essential services such as gas, water, and electricity (Cf. Strategic Bombing Survey, p. 95).

The following summary of Allied bomb tonnage dropped on Germany in World War II indicates how badly the noncombatant fared at the hands of strategic bombing sorties:

Directed against all manufacturing targets	13.5%
Directed against transportation	32.0%
Directed against military targets	30.5%
Directed against large cities	24.0%
Total	100.0%

The Strategic Bombing Survey (Europe) reported: "Tremendous physical destruction was caused and great areas in Germany's principal cities were laid waste. In sheer destructiveness, these raids far outstripped all other forms of attack" (p. 71).

IN order to bring about an effective widespread bomb pattern the Bomber Command of the Allies resorted to systematic attack of German cities which presented a large target area. It was thought that if the morale of German civilians could be affected, or if workers could be diverted from the factories to other purposes, German war production would suffer.

Speaking of area raids the Strategic Bombing Survey says ". . . they were intended *primarily* to destroy morale, particularly that of the industrial worker" (italics supplied).

"The time-honored immunity and asylum afforded civilians is evanescing under the belief that no real distinction exists between civilian population and prime military and industrial targets in modern war."

[1] "Belligerents and nonbelligerents: The distinction between these two classes of persons is, or at least for centuries has been, a fundamental principle of the law of nations in time of war. Nonbelligerents are the civilian population; belligerents those who form a part of the armed forces. . . . Before the war (World War I) the distinction . . . was admitted unanimously and considered essential."—Louis le Fur, *Précis de droit international public.* Paris: Dalloz, 1939, 889-891.

Such an admission would seem to imply that the entire civil population of a warring nation had fallen under the classification of combatant and therefore was subject to direct attack.

The time-honored immunity and asylum afforded civilians is evanescing under the belief that no real distinction exists between civilian population and prime military and industrial targets in modern war. This was clearly brought out in an official publication of the Army Air Force which stated:

"BOMBS behind the fighting fronts may rob armies of their vital supplies and make war so terrible that civilian populations will refuse to support the armed forces in the field. . . . *The physical attrition of warfare is no longer limited to the fighting forces.* Heretofore the home front has remained relatively secure; armies fought, civil populations worked and waited. This conflict's early air attacks were the first portents of a changing order." (*"Target: 'Germany—The Army Air Force's Official Story of the VIII Bomber Command's First Year over Europe."* New York: Simon & Schuster, 1943, p. 19. Italics supplied.)

After affirming that we now follow the "bloody instructions" given us by the Nazis and after describing the destruction of Hamburg and other industrial cities, this official account says: "Here, then, we have terror and devastation carried to the core of a warring nation."

At the Casablanca Conference, we are told, the Combined Chiefs of Staff ordered a joint British-United States air offensive to accomplish "the progressive destruction and dislocation of the German military, industrial, and economic system and *the undermining of the morale of the German people* to the point where their capacity for armed resistance is fatally weakened."

We are further informed that "the two bomber commands lost no time in setting about the job. To the RAF fell the task of destroying Germany's great cities, of silencing the iron heartbeat of the Ruhr, *of dispossessing the working population, of breaking the morale of the people*. The mission of the VIII Bomber Command was the destruction of the key industries by which the German military machine was sustained."

The avowed intent to strike at the industrial potential of an enemy by multiplying the events of catastrophe among the civilian population is fairly clear from the aforementioned citations. The questions to be raised now are two: First, is the assumption that all civilians are essential to an all-out mobilization effort a gratuitous one or is it soundly based? and, secondly, granting that we are fighting a just war and our objective is a morally good one, can we take *any* means to attain that end, even if the disastrous effects, such as the mass killing of innocent civilians and noncombatants, are not proportionate to the advantages to be gained?

Let us consider the first question. Even acknowledging that economic resources and industrial production are as integral a part of modern war as the armed forces in the field, can we sincerely classify as workers essential to the mobilization effort most women, children under 14 years of age, and men over 70, not to mention a host of people who are engaged in activities of a service nature, such as small retail shops not directly related to defense-supporting industries?

About fifty per cent of the United States population is made up of women and fifteen per cent of male children and old men. Allowing that some 15 per cent of the Nation's women work in defense-supporting industry, there are 50 per cent of the Nation (35 per cent who are women and 15 per cent who are male children and old men) who deserve to be included under the prescriptive category of noncombatants.

The class of innocent civilians constitutes an overwhelming majority even in the large centers of war production. For instance consider the New York-Newark area, the country's richest industrial-urban axis with over 10 million inhabitants. Yet in this area, capable of being severely damaged by a 40 megaton H-bomb, only 1,822,343 were engaged in manufacturing in 1951. This figure includes those working in less essential categories such as furniture and fixtures, clay fabricating, etc.

Some 360,563 were engaged in public utilities, transportation, and communication, while some 208,288 were employed in contract construction (McGraw-Hill's Industrial Market Planning Workbook. New York: McGraw-Hill Publishing Company, 1954, pp. 164-165). The total of all employed in the area was 2,391,194. Allowing that every one of these workers was absolutely essential to the mobilization effort, we have less than twenty-five per cent of the entire population of ten million in the New York-Newark industrial axis engaged in defense-supporting work.

CONSEQUENTLY an H-bomb drop on this area would hardly be defensible when the disastrous effects would include the lives and limbs of some 7.5 million noncombatants.

The statement, which has been uttered so often that it now goes unchallenged, that civilian participation in a modern mobilization program is so active and intimate that it must be considered one piece with the military program, is not accurate. It further intimates that armies in the past never traveled on their bellies, depending upon the coöperation of those behind the lines to supply the necessary food, clothing, guns, and ammunition. One observer has aptly summed up the situation, saying:

"Is it not evident that the most radical and significant change of all in modern warfare is not the increased cooperation of civilians behind the lines with armed forces but the enormously increased power of the armed forces to reach behind the lines and attack civilians indiscriminately, whether they are thus coöperating or not" (Rev. John Ford, S.J., "The Morality of Obliteration Bombing," *Theological Studies,* V, September 1944, 281).

DAVID Lawrence would seem to concur with this view: "A few decades ago man did not think it fair or sportsmanlike to attack noncombatants. War was reserved for armies and navies. Civilians behind the lines were immune. At the beginning of World War II we were horrified to see

the German air forces murdering civilians in Warsaw and later at Rotterdam.

"Then came reprisals. The single action of a German maniac—who by skillful propaganda appealing to those in economic distress had seized possession of the minds and energies of a whole people and had directed them along the paths of revenge and brutality—caused other nations to follow suit and bomb cities" (Editorial, *The United States News,* August 17, 1945).

Actually the statement of the Strategic Bombing Survey which distinguished between intended area bombings and unintended bombings would appear to indicate that military officials are aware of the difference between noncombatants and combatants.

The second question concerns the justification of bombing civilians because a grave and proportionate reason exists for *permitting* the disastrous effects on noncombatants which are unintended and only incidental to the primary objective of striking at military targets.

THE Strategic Bombing Survey, as we have seen already, distinguished between area raids and precision raids. A "precision" raid was one made on specific targets, whereas an "area" raid was one intentionally directed against a city area by more than 100 bombers with a bomb weight in excess of 100 tons which destroyed more than 2 per cent of the residential buildings in the city ("Strategic Bombing Survey," *op. cit.,* pp. 71-72). The distinction is a military one, therefore, and not a moral one. This is borne out by the widespread use of "area" raids designed "to spread destruction over a large area rather than to knock out any specific plants or installation; and . . . intended primarily to destroy morale, particularly that of the industrial worker." *Loc. cit.,* p. 71.

Since area raids were endorsed by the Allied air forces there seems little doubt that the airmen in the Allied bomber commands were concerned about the intention as far as the innocent were involved. The moral principle of the double effect permits an unintended evil provided it is not willed in itself and there are grave proportionate reasons for permitting it.

Indiscriminate destruction by nuclear blasts should be controlled by law.

But, since the official record of the Army Air Force ("Target: Germany") and the Strategic Bombing Survey indicated that area raids on large cities and civilian populations were intended as means to win the war, it is hard to escape the logical conclusion that the inadmissible moral principle of the end justifying the means was rather the guiding norm.

As one writer on the ethics of modern warfare has pointed out, in this case the good effect, directly intended, follows the evil which can only be chosen as a means and not a by-product effect. Dr. Ryan explicitly says:

"The actual physical situation in great modern cities is not such that they can be subjected to attack on the principle that only industrial, military, administrative, and traffic centers are being attacked directly while the damage done to noncombatants is only incidental and not an object of direct volition." (Dr. John K. Ryan. *"Modern War and Basic Ethics."* Milwaukee: Bruce Publishing Company, 1940, pp. 105 ff.)

It is understandable that the early German raids on civilian centers should tempt conscionable nations to reciprocate. However it is inexcusable that the age-old immunity of noncombatants to attack should succumb because of bad example.

The failure by the Allies to consider civilian populations in area raids and attacks designed to strike at the morale of the industrial worker, plus the expedient of hoping to hasten the war's end by any means, numbed the consciences of many political and military leaders.

THIS conclusion, the author submits, rests on the recent disclosures made concerning the atomic bombings of Hiroshima and Nagasaki. The question of obliteration bombing and the violation of the historical immunity of civilian populations received a new dimension in July 1945 when the United States exploded the first atomic weapon on Hiroshima.

According to President Harry S. Truman's memoirs, it was the decision of a top-echelon committee, headed by Secretary of War Stimson, to use the atomic weapon against the enemy as soon as possible (*The New York Times,* October 19, 1955, p. 35). They recommended further, Mr. Truman recounts, that it should be used without specific warning and against a target which would clearly show its devastating strength. The testimony of Mr. Truman regarding his decision is interesting:

"I had realized, of course, that an atomic bomb explosion would inflict damage and casualties beyond imagination. On the other hand, the scientific advisers of the committee reported that 'We can propose no technical demonstration likely to bring an end to the war; we see no acceptable alternative to direct military use.'

"The final decision of where and when to use the atomic bomb was up to me. Let there be no mistake about it. I regarded the bomb as a military weapon and *never had any doubt that it should be used.* The top military advisers to the President recommended its use, and when I talked to Churchill he unhesitatingly told me that he favored the use of the atomic bomb if it might aid to end the war" (*Ibid.* Italics supplied).

President Truman goes on to say that he wanted the atomic bomb dropped only on a military target and told Secretary Stimson that this target should be a war production center of prime military importance. Four cities were finally recommended as targets: Hiroshima, Kokura, Nagasaki, and Niigata. Their target value was in that order.

Kokura had a population of 51,663 at the time; Hiroshima, 218,000; Nagasaki, 197,000; and Niigata, 119,600. Kyoto, a larger city with a population of 755,200, was discounted as a military target because Secretary Stimson wanted to avoid attacking a cultural and religious shrine of the Japanese.

Despite the fact that, in Mr. Truman's own words, "the (atomic) test not only met the most optimistic expectation of the scientists but that the United States had in its possession an explosive force of unparalleled power," Hiroshima was A-bombed without any warning. After the first report of the bombing, Mr. Truman issued the following statement:

"We are now prepared to obliterate more rapidly and completely every productive enterprise the Japanese have above ground in any city. We shall destroy their docks, their factories, and their communications. Let there be no mistake; we shall completely destroy Japan's power to make war" (*Ibid.*).

THE irony of the situation is that the big plants on the periphery of Hiroshima were almost completely undamaged and 94 per cent of their workers unhurt, while approximately 60,000 to 70,000 people were killed, and some 50,000 were injured. (United States Strategic Bombing Survey, Summary Report, Pacific War. Washington, D. C.: July 1, 1946, p. 24). The bomb exploded a little northwest of the center of the built-up area. Over four square miles in the center of the city were flattened to the ground with the exception of some fifty reënforced concrete buildings, most of which were internally gutted (*Loc. cit.*, pp. 24-25).

Approximately 40,000 persons were killed or injured in the Nagasaki atomic bombing. The bomb, which exploded over the northwest portion of the city, damaged severely the arms plant and the steel works in the city.

The Strategic Bombing Survey (Japan) indicated that the damage and the casualties caused at Hiroshima by the one atomic bomb were equivalent to 220 B-29's carrying 1,200 tons of incendiary bombs, 400 tons of high-explosive bombs, and 500 tons of anti-personnel fragmentation bombs. It would have required 125 B-29's carrying 1,200 tons of bombs to approximate the damage and casualties at Nagasaki.

THE effects of the two atomic attacks on the Japanese economy make it clear that nuclear bombing leaves no choice to the air strategist of whether he can bomb critical defense facilities while avoiding residential areas and hospital zones. We have seen that "pickle-barrel" bombing in World War II was not employed even when possible; rather the bomber commands of the Allies purposely undertook area raids.

The immunity of noncombatants from attack, often violated in World War II, must be restored as an operative moral principle once again in the law of nations if nuclear destruction is to be avoided as an expedient vehicle of terror.

Many have tried to justify the Hiroshima and Nagasaki bombings on the grounds that they shortened the war. Mr. Truman indicated this reason in his recent memoirs (*New York Times, op. cit.*, p. 35). Undoubtedly it saved the lives of thousands of members of the First, Sixth, Eighth, and Tenth Armies—all of which were scheduled to make amphibious invasions on the Japanese seacoasts. But when we analyze the nature of the causes necessary to permit such an evil effect we discover that it was not a by-product effect, coming from the ending of the war, but a means intended *in itself* in order to produce the good effect, namely the ending of hostilities.

"The immunity of noncombatants from attack, often violated in World War II, must be restored as an operative moral principle once again in the law of nations if nuclear destruction is to be avoided as an expedient vehicle of terror."

The Strategic Bombing Survey clearly shows that the atomic bombing attacks were not essential to the winning of the war: "Nevertheless, it seems clear that, even without the atomic bombing attacks, air supremacy over Japan could have exerted sufficient pressure to bring about unconditional surrender and obviate the need for invasion" (Strategic Bombing Survey, Pacific War, p. 26).

The Strategic Bombing Survey iterated this conviction saying: "Based on a detailed investigation of all the facts, and supported by the testimony of the surviving Japanese leaders involved, it is the Survey's opinion that certainly prior to December 31, 1945, and in all probability prior to November 1, 1945, Japan would have surrendered even if the atomic bombs had not been dropped, even if Russia had not entered the war, and even if no invasion had been planned or contemplated."

Of course, prior to the achievement of air supremacy over Japan the supply lines had been severed and the flow of essentials was cut off by the superior accomplishments of the American Navy in the Pacific.

OBVIOUSLY, wherever general rules of conduct and behavior are discussed there will be always latitude for interpretation of concrete applications. However without any fixed star of morality to guide us in such decisions as to the targets for high-explosive and nuclear attacks, we cannot hope to give an example of shining ideals to our sister nations. As David Lawrence trenchantly expressed it:

"Military necessity will be our constant cry in answer to criticism, but it will never erase from our minds the simple truth that we, of all civilized nations, though hesitating to use poison gas, did not hesitate to employ the most destructive weapon of all times indiscriminately against men, women, and children. What a precedent for the future we have furnished to other nations even less concerned than we with scruples or ideals!" (David Lawrence, "What Hath Man Wrought!," *U. S. News & World Report*, August 12, 1955, p. 108.)

THE THIRTY-EIGHTH ANNUAL MEETING

of the

American Ordnance Association

will be held at

ABERDEEN PROVING GROUND, MARYLAND

on

Thursday, October 4, 1956

with the approval of the Secretary of the Army
and the coöperation of the Chief of Ordnance of the Army

Under the auspices of the Commanding General of Aberdeen Proving Ground a day-long program of current tests and demonstrations of the modern weapons of our fighting forces will be witnessed by the members of the Association.

Complete details of the meeting, including reservation forms and railroad schedules, will be mailed to all members on August 1, 1956.

Meanwhile, mark the date on your calendar and plan to be with the Ordnance fraternity for the celebration of Ordnance Day. Admission will be limited to members of the Association.

High-Speed Air Power

The Air Force Snark SM-62 jet-powered guided missile with intercontinental capabilities, above, takes off from Patrick Air Force Base, Fla., with rocket boosters flaming (Northrop photo). The F-104 Starfighter, below, has razor-thin wings only 7½ feet long and a downward ejection seat. It has flown at a speed of 1,500 miles an hour (Air Force photo).

Aircraft Carriers Today

The strategic and tactical value of the mobile floating air base has been enhanced by the advent of atomic warfare, combining ease of dispersal with powerful defensive and retaliatory capabilities

Charles P. Roane

WHEN the U.S.S. FORRESTAL was commissioned last fall after more than three years of construction work, she was the first carrier to be built with: (1) An angled flight deck; (2) Four deck-edge elevators; (3) A new kind of island, acoustically treated to shut out jet noise; and (4) A primary fly control station that is installed on the after end of the island for adequate control of aircraft landing in the angled deck pattern.

In addition, the new ship's increased catapult capacity allows higher launching speeds, and her higher hangar-deck overheads accommodate larger aircraft.

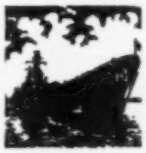
Besides these basic features affecting aircraft design, the FORRESTAL embodies increased capacity for aircraft fuel and speed in servicing, and improvements in electronics installation, fire-fighting devices, and underwater protection.

The 60,000-ton ship has an extreme beam at the flight deck of 252 feet and is 1,039 feet long. She has more than 400 officers and a crew of 3,200.

FOUR sister ships of the FORRESTAL now under construction are the SARATOGA, the RANGER, the INDEPENDENCE, and one as yet unnamed.

The FORRESTAL-class carriers are the latest chapter in the carrier success story. Carrier task forces today are the heart and backbone of naval forces. Regardless of any other capability that carriers may have, their mobile airpower is required for use against enemy forces of any kind which threaten supply lines to our own forces or our allies', in direct support of amphibious operations, and for defense of our forces after landing.

The retaliatory striking power of the United States must be preserved to the greatest possible extent from initial enemy attack. This requirement means dispersion, defense, and deception. The carrier task force has great potentiality in these aspects.



From time to time we hear suggestions that future wars will be decided quickly by thermonuclear weapons launched with intercontinental rockets and missiles and that naval power, land power, and air power as we know them will be of little importance. Let us review some reasons for believing that naval power will still be essential in the future.

First, concede for the moment the possibility that a wholesale use of nuclear and thermonuclear weapons might be made by each side. Concede, also, that this stage of events might be completed in a short time, with destruction of the intercontinental delivery system of one side or both.

But with the passing of that intercontinental stage, the issue would by no means be resolved. Even if an enemy gained initial advantages from the atomic exchange, unless he gained sea control also he could not invade our land and take control of our Government.

Furthermore, if there comes a war in which there is no initial thermonuclear exchange between continents, we will still need naval power to supply and support our land and air forces overseas.

THERE are many reasons for believing that a war in which neither side tries for a quick nuclear knockout is possible:

First, our Nation is building at highest priority the means of deterring nuclear attack on the United States.

Secondly, if we go to the trouble to deter an enemy from initiating all-out nuclear warfare on our homeland, we are going to deliberate carefully about initiating unlimited attacks on his homeland, in response to merely conventional aggression.

We may expect the foregoing con-

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siderations to prevail throughout the 1960's. The will to limit war is in fact likely to increase in direct proportion to the ability of each side to erase without warning the major civilized communities of the other, and with the combined ability of both to poison the globe for all survivors.

Will the aircraft carrier continue through the 1960's to be the backbone of naval power?

We may conclude that carrier usefulness will not decrease. Guided missiles for the foreseeable future are special-purpose weapons. There will be no substitute for the versatility of the small piloted aircraft as a general-purpose weapon for attacking the great variety of fixed and moving airborne, seaborne, and ground targets within the naval missions.

Only the trained pilot on the spot can make the prompt evaluation and decision necessary for selecting targets in a fast-moving situation or when other intelligence is inadequate.

The carrier is the one naval vessel usable alternately or simultaneously against submarines and their bases, surface ships and their yards, aircraft and their airfields, and for the support of amphibious, land, and air operations as well.

THE carrier force of the 1960's will be able to launch both nuclear and conventional weapons in large numbers and variety. It will let us put naval weapons on the spot of action from long ranges when required. As contrasted with other types of forces it allows us quickly to assemble great concentrations of power, to move them about, and to deploy them rapidly. It provides a concentration of defenses that permits us to exert continuing pressure. It provides a base always usable without consultation or negotiation with a foreign government. It is not subject to capture.

For these reasons the carrier will continue to be the heart of the versatile naval power we will require for the foreseeable future, whatever deadly units we may develop for greater effectiveness in specialized tasks.

Ever since the first bombs were dropped experimentally on unarmed,

The SAIPAN, CVL-48, is typical of a light carrier built on a cruiser hull (Navy photo).

unescorted, unmanned warships back in the 1920's, there have been persons who were convinced that navies were doomed. Carriers have received their part of the gloomy forecasts. What are some reasons why the carrier task force defense system can be expected to prove adequate in the carrier era ahead?

First, take defense against air attack. By striking enemy air bases at long range, day or night, we can try to make sure that no air attack can be launched against us. Here the nuclear weapon will help considerably. We rely also on the fact that since our task force is moving, the enemy must find it before he can launch an attack against it. But jet bombers do not have the endurance to hunt far and wide for moving targets. Moreover, there are various ways to deceive the enemy about our location, and our ability to detect and destroy enemy reconnaissance units at a distance is considerable.

If the enemy does launch an attack, and does know where to find the carrier, he will first run into our jet fighters, armed with rockets and guided missiles, patrolling many miles ahead of the force. Such bombers as survive this encounter will next be subjected to long-range missile fire.

With the missiles of 1960, the surface antiaircraft fire zones through which attacks must pass will extend much wider than the few thousand yards they extended in World War II. These missiles will be very accurate and highly lethal, and their fire intensity will increase as they are approached and as batteries of rapid-fire short-range missiles come into action.

THE chances that nuclear weapons can penetrate this formidable defense are at least as low as they are against any other class of above-ground target, and the enemy's ratio of losses may be expected to be as high or higher. And if a nuclear weapon does hit, we shall have such dispersion that no more than one major ship will be seriously damaged.

The dynamics of defense against submarines are similar:

First comes an attack on their bases, supplemented by the mining of their routes of egress.

Secondly, specialized hunter-killer units will seek them out and destroy them en route to our carriers.

Thirdly, the movement of the carrier force will make it difficult for the submarines to get into position for attack.

Finally, against those submarines that may be able to get into position, the Navy is developing greatly improved means of detection and destruction.

One other important point is the potential carrier contribution to that so-called short war, or more properly to the deterring of an all-out nuclear war. If an enemy should sit down to plan a D-day for a surprise nuclear assault on our means of retaliation, these forces would represent several sets of bases of whose location on that day he could not be sure—and which he therefore could not be certain of removing from his path.

THEY are bases which, because they are moving, he could not set up for attack with his long-range ballistic missiles. They are bases which he cannot scour the ocean to find in advance without giving away his intentions. In short, they are one means of powerful retaliation which he could not eliminate by surprise attack.

Variety of base, weapons, operating methods, and tactics gives increased dispersion, depth, and security to our

ultimate deterrent. Carrier aviation contributes much variety to the whole.

The modern aircraft carrier is the only really new type of warship produced in the twentieth century. Building of these ships during World War II was one of the spectacular efforts of the U. S. shipbuilding program.

POSSIBLY excepting the submarine, no craft have ever changed naval warfare more than have aircraft. Today, surface fleets equipped with aircraft can fight each other while hundreds of miles apart. And carriers, the mobile bases, can put aircraft within striking distance of points in a vastly extended battle range.

The main difference between carriers and other large fighting ships has been that carrier armament consists principally of airplanes instead of shells and torpedoes and that airplanes could travel a great deal farther.

Aircraft on the carriers have the functions of scouting, launching initial long-range attacks against enemy forces, protecting their own ships against enemy airplanes, and use on antisubmarine patrols to spot and attack enemy submarines.

The chief function of the carrier itself is to carry, launch, and handle aircraft quickly and effectively. It attempts to approach the enemy secretly, launch its airplane attack, and recover before its position is detected.

Carrier construction features are a large unobstructed flight deck, a hangar deck for aircraft stowage, elevators for moving aircraft from one deck to another, space for repair shops and operational equipment, and a power plant which will provide enough ship speed to assist the airplane to take off and land. The emphasis is on speed, seaworthiness, plane-carrying capacity, and, in the large types, protection against bombs and torpedoes.

Rockets and catapults enable the aircraft to take off in a much shorter distance than is normally required. Arresting gear and special safety screens are used in landing aircraft on the carrier deck.

Before beginning the design of an aircraft carrier these facts must be known: Type of aircraft to be handled, desired speed of the ship, number of catapults to be installed, number and type of arresting gear required, amount and types of ammunition to be handled, complement of personnel to be accommodated, and defensive characteristics and communications required. From this information the size of the vessel can be determined.

A DESIGN must be a compromise from the start. How much of a compromise depends on what the mission of the ship is to be. More machinery can be put into a ship if other features are compromised from the standpoint of weight and space. This statement is true also of ordnance if the ship is to carry a maximum number of guns.

Even in an aircraft carrier, some of the aëronautical features must be compromised to balance the design. Over and above the design features, a margin of weight that can be added to the ship is held in reserve for growth. In some cases, this growth is absorbed even before the ship is completed, and weight must be removed for any weight added.

There are now four principal types of carriers—the CVA, CVS, CVL, and CVE.

The CVA type includes most of the carriers previously designated CVB and CV (MIDWAY and ESSEX classes) as well as the new carriers.

The CVS carriers are used for antisubmarine work.

THE CVL is the so-called light carrier, built on a cruiser hull and displacing from about 11,000 to 15,000 tons. The U.S.S. SAIPAN (CVL-48) is a typical CVL.

The CVE's, or escort carriers, are built up from merchant-type hulls. The U.S.S. BAIROKO (CVE-115) is typical.

The ESSEX-class represents the bulk of wartime construction and current availability. This 27,000-ton vessel, with a speed of about 33 knots, is highly maneuverable. The hangar deck and the hull are armored.

The angled flight deck of the FORRESTAL is clearly seen as the 60,000-ton carrier maneuvered off Cuba recently (Navy photo).

The flight deck of this class is about 880 feet long, a little over 100 feet wide, and has an area of about 2 acres. The island structure on the starboard side contains those stations for the personnel and equipment necessary for control of the carrier and its aircraft. The Essex-class normally operates about 100 aircraft.

Carriers have come a long way since November 14, 1910, the day an airplane was first launched from a ship—the heavy cruiser U.S.S. Birmingham. In three months an "arresting gear" of transverse lines and sandbags made a landing possible on the armored cruiser Pennsylvania. A workable catapult was developed.

IN March 1922 the U.S.S. Langley, a converted collier, was commissioned as the first carrier. Her flight deck was 534 by 64 feet, and her stacks folded down out of the way during landing operations.

Important development in the 1920's was toward large carriers. Under the 1922 Washington Treaty, any new carrier was limited to 27,000 tons, but any hull already under construction and otherwise slated for scrapping could be converted into a carrier displacing up to 33,000 tons—with an additional 3,000 tons if specified protective features were added.

As a result, in 1927, two battle cruiser hulls already laid down were completed as the carriers Lexington (CV-2) and Saratoga (CV-3). Completed at 33,000 tons each, they were 901 feet long, 111 feet, 9 inches of beam, and had a mean draft of 32 feet.

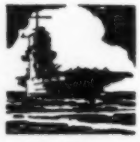
Carrier building then slowed down until the 14,500-ton Ranger (CV-4) was launched in 1933. Before the Ranger was completed, however, it was decided that a more useful size of carrier would displace about 20,000 tons. The result was the Yorktown (CV-5), commissioned in September 1937, and the Enterprise (CV-6), commissioned in 1938.

THESE ships were 761 feet long, with a beam of 83 feet, 2 inches, a draft of 21 feet, 8 inches, and a speed of about 32.5 knots. Instead of the folding funnels used on the Ranger, the island arrangement of offset funnels used on the Saratoga and the Lexington was used.

In April 1941 the 14,700-ton Wasp (CV-7) was commissioned. It had the first deck-edge elevator—now considered a prime carrier requisite. In December 1941 there were eight U.S. carriers. By the middle of 1943 there were 12, including the 27,000-ton Essex-class and the 10,000-ton Independence. By V-J Day there were 28 more large carriers and 71 smaller ones.

On the basis of experience with the Essex and damage reports from World War II, the Midway-class was designed. The Midway (CVA-14), the Franklin D. Roosevelt (CVA-42), and the Coral Sea (CVA-43), were commissioned between 1945 and 1947. These 45,000-tonners have flight decks of 968 feet and can handle 17-ton AJ-1 attack bombers. Each ship has two H-4 catapults and the Mark V arresting gear.

Realizing that the limitations of existing carrier equipment would not support aircraft of superior performance, the Navy began a comprehensive modernization program with the Essex-class carriers. The program dealt with hydraulic catapults of higher capacity, higher capacity elevators, and increased aviation fuel capacity to accommodate the jet aircraft engines.



In addition, provision was made for carrying new weapons. Increased underwater protection, improved electronics equipment, and improved antiaircraft batteries were incorporated.

However, the limit for substantial improvement of this class had been reached. For example, the Essex-class hull had originally been designated at 27,000 tons' displacement. The additional weight of modernization increased the displacement until the weight and moment margins were reduced to a minimum. Further improvements to accommodate larger and heavier aircraft were prohibited.

Anticipating this situation, the Navy designed a new carrier and in 1951 was authorized to begin its construction. The Forrestal is now commissioned.

Two points should be made clear. The first is that the coming of the new carriers does not mean that the old carriers, which are now being modernized, will be scrapped. They are merely progressively stepped down to secondary use.

The modernized Essex-class carriers will operate aircraft now in production, but these carriers will become gradually less useful in carrier striking forces as enemy aircraft developments dictate.

HOWEVER, the later-converted Essex-class carriers can for many years operate lightweight day attack aircraft and the lighter, short-range but high-performance day interceptors. They can do this in the same way that the earlier converted Essex-class carriers can do it for a lesser period—all of them forming an effective balanced team with the new carriers and their more advanced equipment.

Later, when all the Essex-class ships are outmoded by advances in aircraft design, these older carriers can still be extremely useful, if not indispensable, in the operation of lower-performance aircraft used in antisubmarine warfare and in assault helicopter operations.

The second point that needs to be made clear is this: The Forrestal is not a prototype of a new weapons system. For all its bulk, for all its length of flight deck, its list of "firsts," and other improvements, it does not represent even an abrupt changeover in the concept of the aircraft carrier.

What it really is, in the over-all program of keeping our forces stronger than prospective enemies', is simply another logical and orderly step, however mighty, in the development of an already proven weapon.

"We may conclude that carrier usefulness will not decrease. Guided missiles for the foreseeable future are special-purpose weapons. There will be no substitute for the versatility of the small piloted aircraft as a general-purpose weapon for attacking the great variety of . . . targets within the naval missions."

Keeping Our Guard Up

Maintenance of the 2,700 aircraft, 58,000 vehicles, and 718,000 weapons of the Air and Army National Guard is a major task that is being met successfully by modern organization and 25,000 well-trained technicians

Maj. Gen. Edgar C. Erickson

KEEPING National Guard equipment in top mechanical condition requires one of the largest over-all maintenance operations in the armed forces.

If that statement surprises you, consider these figures: The Army and Air National Guard combined have a total of more than 58,000 wheeled vehicles and 2,700 aircraft. The Army Guard alone has more than 5,000 tracked vehicles and 718,000 weapons of all types.

An illustration of how the maintenance operation functions for this vast accumulation of matériel was provided in the years immediately following World War II and leading up to the Korean emergency.

When National Guard units were reorganized in 1946 they received large quantities of "Not Ready For Issue" vehicular equipment. It had to be completely overhauled or rebuilt, and this work had to be done by the States.

Luckily, as it turned out later, the National Guard waded into this monumental job promptly and efficiently by setting up State maintenance shops and hiring full-time supervisors and mechanics.

Four years after receiving the NRFI equipment, this country was plunged into the Korean emergency. There was an acute shortage of many kinds of material. It became necessary to turn to the National Guard, and fortunately the States were able promptly to return to the Army large quantities of the equipment that had been made ready for issue.

General Erickson is Chief of the National Guard Bureau, Washington, D. C.

At one time, National Guard units were levied for 6,000 wheeled vehicles alone. In many cases this equipment was rushed to ports and shipped directly to combat units overseas. A total of eight Army National Guard divisions and numerous nondivisional units were ordered to active duty during the Korean emergency, and many of these were able to report with combat-ready equipment they had received NRFI only a few years before.

The demands of modern warfare make it necessary for the National Guard to be able to accomplish in hours what took weeks or months in past wars. The Guard must be able to move and move fast. And since a unit can move no faster than its equipment, it has become increasingly necessary that maintenance procedures be kept at a peak efficiency at all times.

That applies both to the Army and Air National Guard.

The scope of the job is shown by the fact that vehicular equipment assigned to National Guard units includes 52,970 general and special-purpose wheeled vehicles, 885 engineer track vehicles, and 4,307 other track vehicles.

Maintenance of this equipment covers any action taken to keep the material in a serviceable condition or to restore it to serviceability after it becomes unserviceable. This function therefore includes inspecting, servicing, classifying as to serviceability, repairing, rebuilding, and reclaiming.

MAINTENANCE functions may vary from a simple preventive procedure, performed by using personnel, to complex repair and rebuild technique employed at depot level. Any maintenance function, to be successful and economical, must be assigned to specific levels of command in accordance with the primary mission, character, and mobility of the command, and the economical distribution of funds, skills, technical supervisors, tools, shop equipment, spare parts, and materials.

Maintenance assets should never be wasted by distribution to installation and organizational units whose workloads, equipment, personnel, capabilities, and supply positions are not conducive to efficient and economical operation. Based on this concept, three broad categories of maintenance (organizational, field, and depot) have

been defined by the Department of Defense. These have been adopted by the Army National Guard to facilitate the assignment of maintenance missions and responsibilities.

To provide additional flexibility and accuracy in defining maintenance operations, these broad categories have been subdivided into five echelons, which are numbered consecutively from one through five. These numerical terms as defined below are used within the Army National Guard where additional definitions are required to indicate more accurately the scope, mobility, and capabilities of a maintenance organization or facility—or the personnel, time, tools, equipment, and parts which are available, authorized, or required in connection with a maintenance operation.

Repair of any item of equipment is performed in the lowest echelon of maintenance consistent with the nature of the repair, authorized spare parts, tools, equipment, time available, and skill of personnel. However, no echelon of maintenance performs the work of a higher echelon at the expense of accomplishing its assigned function.

Organizational maintenance is that performed by a using organization on its own equipment. This maintenance normally consists of inspecting, cleaning, servicing, preserving, lubricating, and adjusting, as required, and may also consist of minor parts replacement which does not require highly technical skills. National Guard maintenance normally incorporates the first and second echelons and is broken down in the following manner:

FIRST-ECHELON maintenance is performed by the user, wearer, or operator of the equipment in providing the proper care, use, operation, cleaning, preserving, lubrication, and such adjustment, minor repair, testing and parts replacement as may be required.

Second-echelon maintenance is performed by specially trained personnel provided for that purpose in the using organization. Second-echelon maintenance is authorized additional tools and necessary parts, supplies, test equipment, and skilled personnel to perform maintenance which is beyond the capabilities of first echelon.

Field maintenance, the next higher echelon, is performed by designated maintenance activities in direct support of a using organization. Normally this consists of replacement of unserviceable parts, subassemblies, or assemblies. In the Army National Guard, field maintenance usually incorporates the third and fourth echelons and is broken down in the following manner:

Third-echelon maintenance is performed by specially trained units in direct support of using organizations. A third-echelon unit usually supplies support to a number of using organizations. However, it may be performed by organic maintenance units within the using organization if they can do the job.

Third-echelon units are authorized a large assortment of parts, assemblies, and subassemblies in addition to precise tools and test equipment. They repair assemblies, subassemblies, and the overflow from lower echelons within limits imposed by specified authorization of tools, parts, and test equipment. They also provide technical assistance and mobile repair crews to support lower echelons when necessary.

Fourth-echelon maintenance is performed by units organized as semifixed or permanent shops to serve lower echelon maintenance within a certain area. This echelon is authorized an even larger assortment of parts, assemblies, and subassemblies, and additional and more precise tools and test equipment. The main function of this echelon is to repair assemblies and subassemblies and major items for return to the lower echelons.

Depot maintenance embraces fifth echelon, the highest level of maintenance. It normally supports supply on a rebuild and return-to-stock basis. Fifth-echelon operations are scheduled so as to employ assembly-line methods wherever practicable.

To conserve equipment and achieve greater utilization of vehicles and weapons, the National Guard has established concentration sites throughout the United States.

A concentration site is a location where equipment is stored and maintained when not in use by National Guard units. The equipment is turned in to the site after summer field training is completed and is stored and maintained throughout the remainder of the year.

THIS practice not only assures proper maintenance at a minimum cost but effects a saving in cost of transportation to and from training sites.

Also, a number of units can use the same equipment for field training by coördinating and scheduling their training so that they will be in the training area at different times. This makes possible the training of large numbers of personnel with a minimum of equipment at a still further saving to the taxpayer.

The National Guard maintains 111 concentration sites, 15 of which are located at field-training locations.

In addition to the large number of vehicles and allied equipment, the National Guard also has a large arsenal of modern military weapons ranging from small arms to huge artillery pieces.

At the present time the following weapons are assigned to the National Guard: Automatic antiaircraft artillery, 1,728; field artillery, 1,383; small arms, 678,664; crew-served weapons, 36,731. Here again it is necessary to employ many highly qualified technicians to keep this equipment in top-notch shape.

All personnel working in National Guard shops must be members of the Guard. They occupy the same Military Occupational Specialty slots in civilian jobs as they hold in the National Guard military organization, so that in case any unit is ordered to active duty, each man will be thoroughly familiar with the job he will be called upon to perform. Constant training and schooling is necessary to familiarize each employee with new trends and constantly changing equipment.

For instance, World War II proved conclusively the need of liaison-type aircraft in several branches of the Army. So when National Guard units were reorganized after the war, air-

craft were included in tables of organization and equipment for Artillery, Infantry, Armor, Engineers, and Signal Corps.

New aircraft were not available for issue to units at that time, nor were they in supply channels. So again it was necessary to obtain used equipment, much of which was combat-worn and in need of repair and overhaul.

When the States started receiving these aircraft, they employed Army aviation maintenance officers to supervise and assume responsibility for rehabilitation and maintenance. Experienced airplane and engine mechanics also were hired. These men were experienced in the field of aircraft maintenance, and they had gained valuable knowledge regarding the employment of such aircraft through military experience in World War II.

IT was also necessary to use appropriate tools and shop facilities to accomplish the work satisfactorily. This was often difficult as available tools were frequently unsuitable. In many cases it was necessary to improvise tools.

The aircraft received were placed in a serviceable condition and a concentrated training program was begun. Training programs and schools were established for mechanics and other maintenance personnel to improve the quality of work performed on unit aircraft.

When Guard units returned from active duty after Korea, they received more up-to-date planes. Reconnaissance helicopters were added to Army National Guard aviation sections along with all-metal L-19's. At the present time, multipassenger utility-type L-20's are also being received in limited quantity. This ever-expanding utilization of aircraft to meet the requirements of a highly mobile modern Army requires constant training of highly qualified technicians to stay abreast of current maintenance trends.

Army National Guard units throughout the States and territories are at the present time assigned a total of 656 aircraft. Some of these are ten years old while others in the same organization may have been received in recent months and are the latest models used by the active Army. This wide spread in year and model dictates that organizational mechanics must be proficient in a large number of models, covering a period of over ten years.

The F-94C Starfire with its completely automatic fire-control system meant further study in equipment and maintenance techniques for Air National Guardsmen.

A force of 438 Army aviation maintenance supervisors and aircraft and engine mechanics are employed to perform required maintenance on this equipment and keep it in the best state of repair possible at all times.

Aviation supervisors must be qualified not only in the field of maintenance but in addition, they must be rated Army aviators capable of performing functional test flights. They also must be proficient trouble shooters so they will be able to diagnose a malfunction when equipment is not operating properly.

Some mechanics employed in maintenance work have been rated Civil Aëronautics Administration airplane and engine mechanics for over eighteen years. A number have been employed by some of the Nation's leading airlines as mechanics while others have worked as mechanic instructors in schools conducted by both civilian and military organizations.

BY employing men with this experience and technical background, Army National Guard aviation has been able to maintain the largest pool of trained Army aviation mechanics in existence today.

Vacancies still exist in authorized TO's as funds are not available to employ a full quota of personnel at times. But the airplanes are in excellent condition and should the National Guard be called upon tomorrow to supply such equipment for active-duty units, it would be able to answer the call.

In turning to the maintenance picture of the Air National Guard, we find an organization only ten years old and already actively engaged in the country's air defense. At seventeen installations in strategically vital areas throughout the country, Guardsmen pilots man their fully armed jet fighters on a "5-minute alert" basis, ready to take to the air against any enemy attack.

SINCE August 1954, when this program was started under Air Defense Command control, these National Guard fighter planes have "scrambled" 13,600 times to make 30,500 actual intercepts of unidentified or otherwise suspicious aircraft, and have flown a total of some 34,700 hours.

At present the Air National Guard has assigned to it, 2,124 aircraft, 1,253 of them jet fighters, in 22 wings. As you can well imagine, the build-up to this strength since the founding of the Air National Guard in June 1946 has occasioned some rather severe growing pains from a maintenance standpoint.

At one time in 1947, the Air Guard had more airplanes than it had men to keep them flyable. There were 1,809 civilian technicians, employed on the same basis as those in the Army Guard, to run the bases, shops, and machines required to get the assigned equipment

into operation. And they had the job of caring for 1,965 F-51's, F-47's, B-26's, C-47's, and T-6's.

In addition, those airplanes were generally in the same state of repair as the "NRFI" Army Guard vehicles discussed earlier in this article. And if there is any difference in repairing the automobile or the airplane, it is the life-or-death necessity of maintaining the latter properly—of ensuring its airworthiness before releasing it for flight.

BY the end of fiscal year 1951, a total of sixty-six Air National Guard squadrons, in addition to other units, had been ordered to active duty in the Korean emergency. All of them took their own equipment with them. Others contributed equipment—aircraft, spare parts, even personal items such as crash helmets, life vests, clothing—which was withdrawn by the Air Matériel Command with the approval of the National Guard Bureau.

To illustrate the kind of maintenance structure that has made possible the extraordinary build-up of the Air Guard, we'll "visit" Logan Field, Boston—headquarters of the 102nd Fighter Interceptor Wing, the 102nd Fighter Interceptor Group, and the 101st Fighter Interceptor Squadron, Massachusetts Air National Guard.

There you will find a total of 149 persons employed in the following numbers and occupational specialties: Administration, 26; Supply, 31; Operations & Training, 9; Photo, 1; Ground Training, 6; Vehicle Section, 5; Aircraft Maintenance, 55; Armament, 4; Fire Control, 2; Communications & Radar, 6; and Security Section, 4.

FOR the purposes of this phase of the discussion, however, it is the aircraft maintenance personnel in whom we are primarily interested. Typically, for the 5,783 of them throughout the Air National Guard, they range from commissioned-officer supervisors and test pilots down through venerable master sergeants with 20 to 25 years of civilian and military experience, to "A & E Apprentices" who, very probably, have just recently left active service.

Any airframe or aircraft-engine factory technical representative who has had some association with the Air National Guard will tell you how good they are. Many say their proficiency is equal to that to be found in the Regular Establishment.

One of the biggest jobs these men faced was the rapid changes in aircraft during the past six years. When the Communists invaded South Korea, the Air National Guard—except for 19 squadrons which were familiarizing themselves with the F-80's and F-84's they had just acquired—was what you might aëronautically call a "conventionally propelled" outfit.

Now look at our aircraft inventory as of March 31, 1956: Jet fighters, 1,253; conventional fighters, 154; conventional bombers, 201; air resupply (C-46's and SA-16's), 35; jet trainers, 218; conventional trainers, 128; and transports (C-47's and C-45's), 135.

In all categories, except for transport and air resupply, the conventional aircraft are being phased out of the program and the units operating them are being converted to jets. There are 200 more jets in the Air National Guard today, for example, than there were a year ago. And it appears the remaining F-51 Mustangs and T-6 Texans will not be with the Air National Guard long.

The resultant difficulties are much more complex than even these figures would suggest and to make the problem clear, let's suppose that you are a "do-it-yourself" mechanic.

YOU don your old trousers, get the pliers and a wrench and raise the hood of the family car with every intention of giving it a complete overhaul. There, instead of the old reliable "Straight 4" to which you've subconsciously attached a great affection, you find a radically different engine unlike any you have ever seen before. There isn't even a gear linkage that would make the wheels go around, and the headlights have been replaced by a television receiver that you operate by twisting a grip on the steering wheel. The Air Force opened its technical training schools to Air Guardsmen in exactly your hypothetical predicament.

As a result, as soon as a unit has been advised it is receiving a new type of aircraft, it sends its key maintenance personnel to take the necessary courses. Generally, after they have made the great change from internal-combustion to turbojet machinery and have learned to think in terms of pounds of thrust instead of horsepower, the subsequent assignment of other types of jet aircraft means only that maintenance personnel will have to repeat some specific phase of the schooling.

THEN, too, the Air Force Division of the National Guard Bureau contracts with the supplier to provide technical-representation assistance, a program that has been tremendously helpful to pilots as well as mechanics.

There is yet another group that is very much involved when an aircraft change occurs, however—armament technicians. They quite often have to repeat an entire technical-school course because of a conversion from one gun-sighting or fire-control system to a completely new one. Right now, for example, the F-94C—which has a completely automatic fire-control system and which fires rockets instead of the old familiar caliber .50 machine guns—is being assigned to certain squadrons of the Air Guard.

AND right now, too, there are Air National Guard armament men at Air Force Schools learning the equipment and the techniques they will have to know to make those F-94C's effective—to keep the Air National Guard the alert and ready component it is.

On March 31, 1956, the strength of the Army National Guard stood at 403,634 and the Air National Guard at 62,628. This makes a total of 466,262 Guardsmen belonging to 5,944 units in more than 2,400 communities—the highest strength in history.

The units of the Army and Air Guard are not only better trained and better equipped than ever before, but the 16,000 Army Guard technicians and the 9,000 technicians of the Air Guard who are on full-time duty are capable of maintaining the equipment of the units in a high state of efficiency in peace or war.

A New Training Program

For the first time in its history the Ordnance Corps of the Army is giving executive training to selected officers by combining graduate-level academic study with on-the-job experience at industrial plants

Lieut. Col. Herbert R. Dichtenmueller

FOR the first time in its history, the Ordnance Corps has developed a training program which combines graduate-level academic study with on-the-job experience. This one neat package, designed to give executive training to selected officers of the Corps, is a winner by any criterion.

The idea of sending officer trainees to civilian universities is not new, nor is the practice of assigning them to observation posts in civilian industry. Both have been known since the 1920's, perhaps earlier. But combining both in one continuous experience is an innovation advanced by the Ordnance Training Command.

The "guinea pigs" for this first effort were five lieutenant colonels of the Ordnance Corps who have just recently completed the 2-year program they began in September 1954. All freely admit that the course was one of the most rigorous and demanding assignments they have ever undertaken.

THEY will also insist, with equal fervor, that the program furnished them with training that could not possibly be duplicated at any price were one to try on his own. It was a program, they feel, that will be of inestimable value in their future military careers regardless of the type of assignment, be it field service, industrial, or research and development.

Colonel Dichtenmueller is one of the original five officers who have just completed the first academic-industrial graduate work about which he writes. Before enrolling in the course, Colonel Dichtenmueller was Deputy Director of the Ballistic Research Laboratories, Aberdeen Proving Ground, Md.

The course is of twenty-one months' duration and requires residence in the Chicago area. Chicago was chosen by the Ordnance Training Command because that area best satisfied the unique requirements. It was necessary to locate within a reasonable distance of a variety of medium and large-sized industries with different managerial philosophies and practices and near a first-rate college or university that offered a management training course, preferably one given in the evening so that a maximum amount of training could be accomplished in the minimum of time.

The executive program of the University of Chicago ideally fulfilled the academic need while the Chicago area, as the home of many varied and successful companies, satisfied the industrial requirement.

To better understand the integrated program, it is appropriate to separate it into its two phases, the academic phase and the industrial phase. The academic phase is under the School of Business of the University of Chicago, which offers the executive program—a 2-year graduate course meeting two evenings a week during the academic year.

The academic phase and the manner in which the student body is selected are best described by the following excerpts, quoted from a brochure prepared by the School of Business of the University of Chicago:

"The executive program is for persons already carrying executive responsibility. All courses are presented from the general management point of view, to increase effectiveness of performance in any responsible position. The overall objective is the development of broad senior management personnel. Admission to the executive program is on the basis of individual application and interview.

"Each candidate is considered from three points of view:

"(1) Is he competent to do graduate work? (2) Can he make substantial contributions to the program from his administrative experience? and (3) Does he exert an important influence upon enterprise operations?"

Admission to the executive program is selective. Seventy-five men are admitted each fall and experience has

shown that there are always many more applicants than openings. Actually, there were more than 300 applications for the twelfth group, the first group into which military personnel under military sponsorship were admitted. Five more Ordnance officers now are enrolled in the thirteenth group which began classes in the fall of 1955.

Those who enter the program with degrees from accredited colleges receive the degree of master of business administration after its successful completion. The opportunity also exists for those who do not have their degree, but who do have two or more years of college and who are able to pass a series of six comprehensive examinations, to obtain an MBA.

The academic requirements of the program are stringent. During the first year the officers took two courses in managerial accounting, each requiring fifteen to twenty hours of work per week by a nonaccountant, plus additional hours spent doing required reading.

The first-year academic program also included one-semester courses in administrative relationships, business economics, industrial psychology, and management statistics. Three of these courses required weekly papers.

THE industrial psychology course, called "Industry and the Individual," had two term papers as a requirement, and each of the other three courses required term papers in addition to the weekly papers. Thus, a week in which less than thirty hours were devoted to study was a rare one.

The second year was just as rigorous as the first and relied heavily upon the subjects taught in the first year as tool subjects. This was particularly true of accounting, management statistics, and business economics. Second-year subjects include marketing management, money and the financial markets, financial management, public regulation of business, manufacturing management, and theory of management.

A rather extensive list of suggested reading is furnished by the university so that the free time during the summer vacation can be profitably employed.

The Ordnance officers found the stimulating class discussions to be one of the chief benefits of the academic phase at the University of Chicago. Several of the Nation's leading industries were represented among the students. Each class member brought to the discussions information and experience from methods and approaches used in the solution of management problems at the company he represented.

Another important attribute is the high caliber and competency of the faculty of the executive program.

While, practically every member of the faculty has a Ph.D. degree, none can be accused of being mere academicians without the "trial-by-fire" acceptance of industry.

Almost without exception, the faculty members are on occasion employed by industry in consultative capacity—a measure of respect, since industry is loathe to spend money for something on which the return is intangible.

The industrial phase of the Ordnance Corps Executive Training Program, which runs concurrently with the academic program at the university, consists of seven 3-month periods spent in the following manner:

First, three months are spent at the Chicago Ordnance District, where, under the direction of the district chief, the students are oriented in all phases of district operations. Here again, the Chicago choice was a fortunate one since the Chicago Ordnance District is one of the largest and one in which all phases of Ordnance operations are represented.

THE second three months are spent at Inland Steel Company, a completely integrated basic steel producer with essentially a one-plant operation at the main works at Indiana Harbor, Ind. This is followed by a 3-month stay at Borg-Warner Corporation, an example of widespread autonomous operations, and a 3-month tour at International Harvester Company, which has worldwide autonomous operations coupled with a strong central control.

The fifth period is spent at Sears, Roebuck and Company, which has and solves many of the same problems facing the technical services of the armed forces. Prime among these common problems is one of the storage and distribution of a wide variety of products over a wide geographical area. The last industrial organization visited is Motorola, the youngest of the firms in the program but among the best from a management standpoint.

The seventh and concluding 3-month period also is spent at the Chicago Ordnance District where the officers then try to put into practice some of the things learned during the industry-academic training program.

This final period also permits additional orientation on areas of particular interest, such as the commodity commands, electronic data processing, and the rôle of banks and the Federal Reserve System in times of national emergency. It will also permit a few short plant visits to installations manufacturing Ordnance items.

IN addition to the burden of reports demanded by the academic program at the university, another requirement is a complete report by participating officers on each 3-month period of the industrial phase of the program. Upon completion of the twenty-one-months, these reports will be summarized into an over-all evaluation report.

The industry phase in each of its seven sections involves a full eight hours or more a day, five days a week. The officers just completing the course felt that all companies visited went all-out to make the program as valuable as possible, and this coöperation by industry has led the men to insist that the program is "something that no amount of money could buy."

The officers were met by the top echelon of management, including the chairmen of the boards of directors and the presidents of the organizations. Vice-presidents and managers of major divisions spent as much as several days with the group.

This attitude was obviously a sincere one, and one of the brightest spots in the entire program has been the wholehearted and enthusiastic support and acceptance of the program by all echelons of management in all the industries visited.

Army Missile Power

The trend of modern artillery toward rockets and guided missiles is shown in these Army photos. The Honest John rocket, above, is just leaving its mobile launcher during training by the 7th Field Artillery in Germany. The Corporal surface-to-surface Army guided missile, below, can engage tactical targets far beyond normal artillery ranges.

"Miracle of World War II"

A review of Francis Walton's recent book on the problems and the achievements of American industry in producing the myriad weapons and other equipment which finally overwhelmed the Axis powers

Brig. Gen. Donald Armstrong

OUR industrial manpower and management achieved modern production miracles during the Second World War. These accomplishments are recounted in most interesting fashion in a well-documented, well-written, and, above all, well-deserved eulogy of American industry in the war against the Axis ("Miracle of World War II—How American Industry Made Victory Possible." By Francis Walton. New York: Macmillan Company. 575 pages. $7.50).

Near the end of the book the author reminds us that "the United States in 1944 built one plane every 5 minutes, produced 150 tons of steel every 60 seconds, turned out 8 aircraft carriers a month, and launched 50 merchant ships each day."

These figures illustrate some of the "miracles" of World War II. The list could be prolonged by naming hundreds of other end products of our factories and plants which were instrumental in winning the war. But these records, it must be emphasized, are the accomplishments of 1944. We had begun our apprenticeship in military manufacture in 1939 with occasional orders for Britain and France. We had commenced our own increased war production a year later and in 1941 we went to work in earnest.

Call these industrial achievements "miracles," but to the participants who are still alive, there will be agonizing memories of weeks and months spent in contract negotiation—of months extending well over a year as factories took shape, as machine tools and other production equipment slowly arrived, as men and raw materials and semi-finished articles were gradually assembled and prepared for their war duties.

Mr. Walton makes all this abundantly clear. He repeatedly calls attention to time, the essential ingredient we enjoyed without let or hindrance in World War II. We were in a war of attrition, possibly the last of this kind of war the world will ever see. We were not surrounded by smoking cities in ruins, by factories in ashes, by power plants without power and railroads without rails and bridges and locomotives.

So in reading this proud record of achievement let us have no delusions that we still live in an age of miracles—that we can repeat in a nuclear war the kind of industrial mobilization which gave us the weapons for victory in World War II.

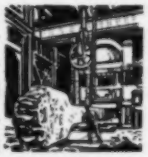
NO matter what kind of conflict we may face in the future, however, Mr. Walton's book will help us solve our problems. In these pages we can discover the devices and the methods that succeeded, and we can arm ourselves against the repetition of the mistakes that caused our delays and failures.

Mr. Walton gives more specific information about American industry in the late war than has previously been gathered together. He penetrates the most mysterious recesses of the factories and of mass production. He watches the lathes and planers and other production equipment transforming their output from washing machines to machine guns. He observes management and engineering staffs increasing productivity, and the men and women in industry adjusting to the new machines of war.

He does this with rare insight into industrial operations and with rarer

General Armstrong has a distinguished career as an Army Ordnance officer, industrial executive, and educator. As Commandant of the Industrial College of the Armed Forces, his scholarship had wide application and helped establish the college in its recognized place as one of the leading educational establishments of the Department of Defense. He is presently serving as a consultant to the State Department in its overseas educational activities.

ability to tell a good story about a subject that ordinarily lacks popular appeal and glamour. Readers with little knowledge of industry will not be stopped by overly technical details. They will be impelled to read further because Mr. Walton never overlooks the human beings behind the machines and in the offices.



The rôle of big business in war is extremely well analyzed in this book. With profound conviction and with much evidence Mr. Walton writes: "Big business carried most of the burden of industrial mobilization for war. Without this type of enterprise there would have been neither volume nor diversity of goods, neither power nor technological ingenuity—in time. The multitude of small and medium-sized companies played their part, but there could have been no victory without the giant corporations" (p. 398).

WHEN Mr. Walton pays his respects to what he accurately calls "one of the greatest deluges of paper work ever suffered by man," every victim of this flood will enthusiastically agree. He adds: "Filling out Government forms, in one period, cost one large automobile company engaged in war production $125,000 and 100,000 man-hours of office work.

A small manufacturer of gun parts fell so far behind in his Government paper work that he had to shut down for three weeks to catch up. Much of this burden developed directly from Washington bureaucratic procedures and from inefficiency formalized into unbreakable practices and effectuated by ceaseless demands for records, reports, fiduciary statements, analyses, and forms *ad infinitum*—all in triplicate at the very least."

MR. Walton had better not look now, or he would be dismayed and wonder whether or not this country can ever win another war with the contractual procedures and paper work presently demanded. We may someday have to choose between filling out forms, keeping records, and winning a war. We can scarcely do both!

His book contains scores of case histories that illuminate the scene. The stories of machine tools, of the proximity fuze, of ship and airplane building, of die casting and its struggle for recognition, of the atomic bomb, and of many individual companies are a fascinating record of achievement.

The meaning of mass production, the factors influencing productivity, the essential value of standardization are all brought out. The interdependence of American industries, the teamwork of big and little industry in subcontracting are useful in gaining the recognition by our people and by our politicians of the way war contracts get down into the grass roots.

Members of the Ordnance fraternity will find little recognition of the value of their planning and prewar labors in Mr. Walton's history. In fact, the so-called "brass" of the armed forces are usually classified with politicians and the superagency personnel as among the obstacles that industry had to overcome.

A reviewer might easily defend these groups against at least some of these allegations. In glorifying American industry it was unnecessary to write slightingly or contemptuously of these organizations, most of them expanded far more than industrial management ever was.

Can any adverse comment against the Ordnance effort of the Army and Navy be more unfair than the following remark by Mr. Walton when writing of Government production?

"While it dabbled in railroading, in metal extraction, in synthetics, and produced and sold fertilizers, it could not for some reason produce satisfactorily in the one field which was basic to the country's survival—the building of weapons for its own defense. Most of the important Government arsenals had to be managed by private companies" (p. 126).

No comments, for the readers of ORDNANCE will supply their own!

A most useful aspect of Mr. Walton's book is his reference to civilian morale as a factor in winning the war. It was of inestimable value in transforming our industrial potential in World War II. It continues to be an essential element today. If an enemy with less potential builds stronger actual forces we are in mortal danger.

If the people of another nation work harder, develop more productive capacity, reduce their standard of living or fail to improve it, suffer inconveniences that we are unwilling to endure, obey more readily a government that interferes with their lives and personal desires than we Americans, we may not only lose a fighting war. We may be defeated in the Cold War.

WHAT of the future in the light of the past?

Mr. Walton has shown us the importance of time in mobilizing our factories in World War II. If we are not to make the egregious mistake, which has been charged against the military, of always planning to fight the last war over again, we must realize what the prospect of nuclear war means to our industrial potential.

Space is now as essential an element on the home front as time was in the past. Concentration of population and industry in obvious target areas weakens our national security. We have the space to lessen this great danger, but we are not sufficiently impressed with the urgent need for far greater dispersal than anything we have so far accomplished.

We can greatly reduce our vulnerability to air attacks and prepare this country for the coming era of guided missiles by dispersing, with the aid of wise governmental policy in taxation or even in subsidies, the industrial resources of the Nation. This will increase the difficulty of effective enemy attack and consequently reduce the danger of war, so the cost of dispersal is a justifiable charge in our defense budget.

WE must heed Mr. Walton's lessons concerning time in planning a future mobilization. Now, at this moment, industry and labor and the Government must find an effective solution to the problem of space, because the solution to this problem will not and cannot await the nuclear attack that may otherwise end in our destruction and defeat.

Defense Highlights: Monthly Review and Outlook

Arms Program for 1957

The House of Representatives unanimously voted $33,635,066,000 to maintain the strongest peacetime military establishment in American history.

President Eisenhower had previously stated that the national-defense program met this country's needs. The President said it would be "dangerous" to try to match a prospective adversary in every category of weapon or man for man.

The bill as passed by the House cut $512,784,000 from the $34,147,850,000 requested by the President in January. This did not eliminate any vital activities. Almost half of it was due to bookkeeping adjustments and program revisions since last January.

The House deleted from the bill a provision that would have continued the power of the congressional appropriations committees to veto any Defense Department proposals to dispose of such commercial-type activities as laundries and coffee-roasting plants.

The proposal to add one billion dollars to increase B-52 long-range bomber production was defeated because the House was informed that the Air Force had neither the trained crews nor enough bases and other facilities to absorb more B-52's than were in the program.

In the hearing before the Senate Appropriations Subcommittee there was a clear indication, in the testimony received, that the United States can cope with any war that may develop soon.

The Chairman of the Joint Chiefs of Staff, Adm. Arthur W. Radford, said that the manpower levels are adequate to "perform all essential tasks in the initial stage of a shooting war, global or otherwise."

Secretary of the Army Brucker said the Nike could "bat down" any Communist plane of any speed or ceiling.

Army Chief of Staff Taylor said that the active forces of his service "represent the minimum requirements to satisfy the Army's day-to-day responsibilities."

Secretary of the Navy Thomas, stressing the Navy's growing capability for strategic air strikes, had this to say:

"With its newest planes, now being introduced into the fleet, there will be few important targets in the world that the Navy, if called upon, could not reach with atomic weapons."

There is no question about the determination of the American people to remain strong. The only question is: how strong?

Military manpower will be increased by 45,100 during the 12-month period beginning in July.

The House Appropriations Committee has approved a projected personnel strength of 2,865,200 for the four services by June 30, 1957. This compares with an estimated strength of 2,820,100 on duty on June 30, 1956.

Here is the way the personnel picture looks for next year:

Army	*1,045,300*
Navy	*678,100*
Marines	*205,700*
Air Force	*936,100*

Of the $33.6 billion of new appropriations voted by the House, $7.5 billion will go to the Army, $10 billion to the Navy, and $15.5 billion to the Air Force.

The Army's $7.5 billion included $1.4 billion for procurement and production facilities.

The $10 billion voted the Navy included the full budget estimate of $1.5 billion for new shipbuilding and ship conversion, including a sixth FORRESTAL-type carrier, twelve destroyers and frigate-type guided-missile ships, one nuclear-powered guided-missile cruiser, and six nuclear-powered submarines.

Provision also was made for the conversion of twenty-three ships and for advanced material procurement for a nuclear-powered carrier and another guided-missile vessel.

The Navy got the full budget request of $1.7 billion for new aircraft and related items. This will cover the procurement of 1,468 new airplanes, which, coupled with prior procurement, would provide about 2,000 airplane deliveries a year through 1958.

Funds voted for the Air Force cover the continuing expansion of the Air Force toward its 137-wing goal by June 30, 1957.

Six billion dollars was allocated for aircraft and related procurement. This amount will permit the procurement of 1,927 airplanes. A total of $1.1 billion was voted for guided-missile procurement, $2.1 billion for procuring aircraft components, $1.1 billion for communications, ammunition, vehicles and other equipment, and $610 million for research and development.

Atomic-Fueled Fleet

The American Navy has a rendezvous with atomic energy. In the next decade our Navy hopes to achieve atomic propulsion for all major combat ships, from submarines to aircraft carriers.

A start has already been made, and it now seems likely that all major naval ships constructed after 1960 will be nuclear-powered.

Our Navy is being rebuilt from the keel up into a faster, more mobile, more powerful striking force. According to one Navy leader, Rear Adm. H. G. Rickover, the impact of the NAUTILUS on naval tactics "may well approach that of the airplane."

The NAUTILUS was the pioneer atomic-powered submarine. It so exceeded all expectations that it constitutes a significant turning point in modern American naval history.

In a little over a year of experimental operation the NAUTILUS has traveled more than 26,000 miles without refueling and can probably go another year without new fuel.

In terms of speed, the new submersible traveled 1,300 miles, fully submerged, in 84 hours. This was many times faster than any other submarine is known to have traveled under water, and the voyage was made faster than any other submarine is known to have done it either below or on the surface.

All the power needs of the NAUTILUS *are supplied by an atomic reactor which can supply the power needs of a city of 20,000 people.*

By way of comparison, Diesel-powered submarines, relying on storage batteries for submerged power, could travel for only about half as long below water as the NAUTILUS and then only at the very lowest speed.

With nuclear power, according to Admiral Rickover, the Navy "can go where it wants, when it wants" at top speed and without worrying about the limitations of fuel capacity. He added that the striking power of a nuclear Navy task force would be many times that of a World War II task force and would require only a small percentage of the ships.

The cost of nuclear submarines is considerable. Navy figures show that an "average" nuclear submarine costs $47 million to $50 million, against some $22.5 million for a Diesel-powered craft. An atomic carrier will cost much more than a conventionally powered carrier.

Westinghouse will build a large surface ship propulsion reactor prototype that will cost about $25 million. Newport News is designing an atomic aircraft carrier which will probably cost more than $200 million.

Because of atomic power our Navy's fighting craft will become largely self-sustaining fighting platforms. Because of their mobility our ships will be difficult to hit. They will move over a wide area quickly, hit hard, and escape fast.

Nuclear-powered craft will be able to operate at full speed at all times, rather than having to conserve full power for the time of attack.

As Adm. Arleigh A. Burke, Chief of Naval Operations, expressed it: "With nuclear power the Navy will be able to design its combat ships around their power plants and weapons rather than around their fuel-carrying capabilities."

Our Strategic Stockpile

Congress in 1946 authorized the purchase and storage of strategic materials for war use. The over-all stockpile objective contemplated the purchase and storage of $11,200,000,000 worth of critical and strategic materials.

The total program is aimed at ensuring an adequate stock of critical war materials despite possible interference with imported supplies and damage to domestic supply sources in event of war.

Today the United States has completed the stockpiling of half of the 74 critical materials it will need in case of emergency. The most recent information is contained in a report of the Office of Defense Mobilization which covers the period from July 1 to December 31, 1955.

The stockpile is divided into two groupings, for which "minimum" and "long-term" goals are set.

The minimum stockpile objectives discount to a degree distant and unreliable foreign sources of supply.

The long-term stockpile, established in 1954, was designed to provide additional materials security for metals and minerals. This was done by setting objectives at quantities large enough to eliminate any wartime reliance on distant supply sources.

The products for which purchasing has been completed for both the minimum and long-term stockpile needs are:

Abrasives; crude aluminum oxide; chrysotile asbestos; crocidolite asbestos; Madagascar crystalline flake graphite; graphite, other than Ceylon and Madagascar crystalline; rare earths; tantalite and vanadium.

Products for which minimum stockpile objectives have been reached are:

Agar, aluminum, bauxite, cadmium, castor oil, coconut, columbite, abaca cordage fibers, sisal cordage fibers, extra-long-staple cotton, industrial diamonds, acid-grade fluorspar, graphite, Madagascar crystalline fines, hyoscine, lead, battery-grade manganese natural ore, metallurgical grade manganese ore, and mica.

Also palm oil, pyrethrum, quartz crystals, quinidine, natural rubber, sperm oil, tin, tungsten, chestnut vegetable tannin, quebracho vegetable tannin, wattle vegetable tannin, and zinc.

Strategic and critical materials on hand at the close of 1955 were stored in 259 places throughout the country. Deliveries to the stockpile during the 6-month period covered in the ODM report amounted to $167,000,000. Goods held in storage increased $433,000,000 in value during that period largely through price increases.

Three Electronic Fences

A gigantic electronic warning system against possible enemy aircraft on the transpolar air approaches to the North American continent is being constructed on schedule.

The first electronic fence is the Pine Tree radar chain which stretches across the continent along the United States-Canadian border.

The second electronic fence is the Mid-Canada. It will cross Canada at about the 55th parallel.

The third radar defense chain is popularly called the DEW or Distant Early Warning Line. It is being built some 1,400 miles north of the United States-Canadian border and will stretch from Alaska across Canada to Baffin Island.

The DEW Line is a magnificent achievement of the U. S. Air Force. It is being built in a subzero desolate area that poses innumerable problems of logistics and personnel. Dozens of stations are being built, however, and technical difficulties are being overcome.

Work on the DEW Line was started

more than a year ago, and the entire project will be completed in about two years. It will provide four to six hours' warning of the approach of enemy aircraft.

An intensive airlift touched off the start of construction. This was followed by a mammoth Navy supply operation last summer. The radar line positions are isolated and exposed to the full fury of Arctic storms. The foundations for radio and radar towers were drilled in temperatures around 30 degrees below zero.

New Infantry Equipment

In any future war the Infantry, as in all past wars, will have a key rôle. It is the policy of the United States Army to do everything in its power to help the Infantry to accomplish its mission.

At Fort Benning, Ga., the Army has established one of six testing units or CONARC Boards. These boards all have the same mission in that they present the user's point of view at various phases in the development of new weapons and equipment.

In essence, the boards serve as the connecting link between the user and the developing agency.

The development policy of the Army may be briefly stated:

The Infantryman's task is the most difficult in modern war. It is imperative, therefore, that the Infantryman be provided with the best possible equipment. Improvements in Infantry equipment should stress:

1. Reduction in weight. The highest priority in the allocation of lightweight materials must be accorded man-borne and manhandled equipment.

2. Simplicity and reliability of operation. Men cannot be relied upon to perform complex mechanical operations under stress of battle.

3. So far as practicable, all Infantry weapons and equipment should be capable of being separated into component loads, each weighing not more than 25 pounds and having a form factor and degree of ruggedness to permit their being jumped on a parachutist without jeopardizing their primary ground rôle.

The 45-pound combat load has been separated into two components: (1) a 20-pound existence load, which includes the items for the individual's own maintenance, and (2) a 25-pound battle load, which may be a weapon, weapon component, and/or ammunition, which will be the individual soldier's contribution to the fighting effort of his unit.

The Williams Doctrine

The review of "Lincoln and the Tools of War" in this issue of ORDNANCE (page 126) contrasts the Army Ordnance policy of supplying to the using arms—Army, Navy, and Air—the weapons they want. It was not always so!

There was a time in the old Ordnance Department of the Army of nearly a century ago when the Department, assuming a very adamant attitude, prescribed the military specifications of each new weapon and insisted that they be followed rather than the characteristics as set forth by the user.

The father of the present joint policy is none other than the revered Maj. Gen. C. C. Williams, renowned Chief of Ordnance of the Army, 1918-1930, who now lives in retirement at his home in the Shenandoah Valley at Woodstock, Va. Many notable policies and achievements are recorded in the annals of Ordnance which will redound forever to the credit of General Williams and his farseeing understanding of human as well as technical problems.

Of these, one of the greatest was his announcement at the beginning of his tenure during World War I of a policy which has dominated Army Ordnance ever since—give the using services what they want.

The missileman, the artillerist, the infantryman, the gunner aboard ship, and the bomber and gunner aloft must specify the military characteristics of the weapons with which they fight. They are the users, and they alone know best what they need to accomplish their missions. It is for the Industry-Ordnance Team to produce the best possible weapons to meet those requirements.

It is a far day from the time when General Ripley, Chief of Ordnance during the American Civil War, took the position as described in "Lincoln and the Tools of War" that he and his advisers knew best. We have come a long way since, thanks to those sterling successors of General Ripley as Chiefs of Ordnance and to their colleagues who are determined to follow the Williams' Doctrine—give the user the weapons he wants ashore, afloat, and aloft.

The National Guard

An editorial comment in these pages in a recent issue concerning the high state of efficiency of the National Guard —land and air—has brought notable favorable comment.

For this friendly and helpful confirmation of our views on a highly important segment of our national defense system we are most grateful.

It is our intention to continue to stress in this journal, and with increasing vigor, the considerable value and worth of the Guard in our defense readiness.

Thus General Erickson's article on page 55 of this issue is especially welcome. The armament problems of the Guard are a major concern to the Industry-Ordnance Team. It is heartening to read the general's comprehensive and timely analysis. The Guard can count on armament support from the A.O.A. at all times.

The Guard's long record of achievement, in times of domestic disturbance, in civil war, and in international war, is one of the most encouraging of our spotty military history.

The Guard itself has at times added to this spottiness no less than the other components of the defense team. But by and large the National Guard rests securely on more than its mere constitutional status.

It is of the people, up from the grass roots. It is composed of home-town boys who have grown up together, who play together, work together, pray together, and fight side by side.

The Guard has morale factors inherent in it which normally and naturally follow the command to love one's neighbor—particularly in time of peril.

Armament Preparedness

An Editorial

THE basic armament problem throughout history has always been to reconcile complacency and dissatisfaction, accomplishment and improvement, the status quo and the challenge of the future. That problem is the dominant note of our national defense today more than ever before.

The moment armament authorities in the United States begin to relax, to take things easy, to look backward instead of forward, to pride themselves on past honors and hallowed traditions, at that precise moment they begin to stagnate, to decline, and to surrender themselves to the twin demons of sterile routine and red-tape bureaucracy. That being clear, it is equally clear that very little is gained by morbid, pessimistic, uninformed, and destructive criticism and complaint.

What is most desirable is an honest audit of the existing situation, coupled with a determination not to rest on ancient laurels but to go forward tirelessly in search of the better way. Despite some disturbing evidences of interservice bickering, there are many encouraging signs.

For example, when the Army Ordnance Corps recently observed its 144th birthday, most appropriate to the occasion was the estimate of Ralph M. Beese, chief of the Cleveland Ordnance District, before the Cleveland Post of the American Ordnance Association at the Hotel Statler in Cleveland on April 3, 1956. Mr. Beese had this to say in praise of current Ordnance operations:

"I ASKED for the opportunity to tell this assembled group of a job that I think has been done not merely well but with a high degree of excellence. There is a prevailing sentiment abroad that Government is inefficient, and I must confess that there is some evidence of it. I approached my Army Ordnance assignment with the same point of view. But it is an erroneous conclusion that just because some government is inefficient, most government is inefficient.

"I am very pleased to confess tonight that I have found an operation that matches in its efficiency the kind of business efficiency that characterizes the best of our industrial companies. And it comes about, I think, for three reasons:

"First, because this Cleveland Ordnance District, and I am sure that it but reflects the condition that prevails throughout the Ordnance Corps, has been careful in the selection of its personnel—a difficult thing. Army Ordnance does not have the kind of wage allowances that industry has available for its people.

"Secondly, because the Ordnance district has an *esprit de corps* that I have not seen matched in any comparable organization anywhere. Ordnance personnel constitute a dedicated group of people.

"Thirdly, and most surprising to me, I believe it is true because this operation is applying a broad sense of fundamentally sound business and management principles. . . .

"In fact, I find that one of the most extensive business training courses I know of in any organization is continuously conducted by the Army Ordnance Corps.

"So again I say that I am happy to appear before you, in effect as a Committee representative, to report to you that your money is being well spent in the Ordnance Corps; that you can be proud of the performance of this group of people who with dedication and spirit and tolerance are protecting the United States now and in the future."

Ordnance personnel, military and civilian, in many parts of the world are grateful to the distinguished business leader for his friendly assurance that Ordnance is doing a highly commendable job in the conduct of its complex task of supplying superior ordnance to the best fighting men.

While acknowledging Mr. Beese's generous tribute to Ordnance efficiency, however, Army Ordnance continues, by constructive self-criticism, to seek and to find the better way.

PERHAPS this wholesome spirit of constructive dissatisfaction has been best expressed, in recent months, by Maj. Gen. E. L. Cummings, Chief of Ordnance of the Army, in an address at the Ordnance School, Aberdeen, Md., on March 20, 1956. General Cummings emphasized the following five points:

1. We must continue to arm our fighting men with ordnance equipment and weapons superior to those in the hands of the aggressor. In our struggle for survival, there are no prizes for second best.

2. We must accept and exploit the present and coming revolution in weapons and weapons systems. We must go out to meet the future.

3. We must never be satisfied with things as they are. We must spur ourselves always to find the better way.

4. We must work *with the team* to achieve our goal of security from aggression. The team is the Army, the other armed forces, and the defense forces of our friends and allies.

5. We must accept and discharge a personal share of the national and free-world defense responsibility. We must do our part of the job ourselves.

The Ordnance Corps which General Cummings directs so competently and progressively is closely linked with the American Ordnance Association and its local Posts. The Ordnance-Industry Team is a heartening model for Industry-Government coöperation in defense of freedom.

All members of the American Ordnance Association are looking forward with great anticipation to the forthcoming demonstration of ordnance at Aberdeen in October (see announcement on page 49).

American ordnance is today the best in the world. It will continue so tomorrow only if the Industry-Science-Ordnance Team continues to search for the better way.

Navy Sea Power Today

The U.S.S. JOHN PAUL JONES (DD-932), above, is one of the newest additions to the Navy's destroyer force. The U.S.S. BOSTON (CAG-1), below, is the Navy's first guided-missile cruiser, shown here under way off Guantanamo Bay, Cuba. In addition to powerful conventional armament, the BOSTON carries batteries of Terrier guided missiles aft (Navy photos).

ASSOCIATION AFFAIRS

Board of Directors Decides To Use Crozier House as A.O.A. Headquarters

A special meeting of the national Board of Directors of the A.O.A. was called in the Nation's Capital on Thursday, May 10th, at the Sheraton-Carlton Hotel to consider the disposition of Crozier House, former Washington residence of the late Maj. Gen. and Mrs. William Crozier which was bequeathed to the Association.

After a review of the possible solutions to the utilization of Crozier House the Board unanimously agreed that a program should be undertaken to develop the Crozier property as a headquarters for the Association.

At noon the meeting adjourned to greet the many distinguished luncheon guests who assembled in the Carlton Room. Officers and directors of the Association present were: Vice Adm. George F. Hussey, Jr., president; Vice-presidents Harvey C. Knowles, Louis Polk, Col. Daniel J. Martin, Col. John S. Pfeil, and Col. William J. Rushton; Directors Lieut. Gen. Levin H. Campbell, Jr., William K. Fitch, Col. Herbert A. Gidney, C. Jared Ingersoll, Col. Henry N. Marsh, Col. F. H. Payne, S. E. Skinner, and J. E. Trainer; Assistant Counsel John F. Floberg; and Executive Vice-President Leo A. Codd.

The distinguished guests were: Hon. Charles E. Wilson, Secretary of Defense; Dr. Allen V. Astin, Director, National Bureau of Standards; Hon. Wilber M. Brucker, Secretary of the Army; Brig. Gen. F. E. Calhoun, deputy commandant, Education Division, Industrial College of the Armed Forces; Rear Adm. H. T. Deutermann, deputy commandant, Industrial College of the Armed Forces; Maj. Gen. Edgar C. Erickson, Chief, National Guard Bureau; Lieut. Gen. F. F. Everest, Deputy Chief of Staff, Operations, U.S.A.F.; Roger E. Gay, Office of the Assistant Secretary of Defense; William E. Haines, Business and Defense Services Administration.

Also present were: Maj. Gen. J. H. Hinrichs, Deputy Chief of Ordnance; Maj. Gen. Robert P. Hollis, Commandant, Industrial College of the Armed Forces; Eger V. Murphree, Special Assistant to the Secretary of Defense for Guided Missiles; Hon. Frank D. Newbury, Assistant Secretary of Defense (Applications Engineering); Lieut. Gen. Emmett O'Donnell, Jr., Deputy Chief of Staff, Personnel, U.S.A.F.; Gen. W. B. Palmer, Vice Chief of Staff of the Army; Hon. Thomas P. Pike, Assistant Secretary of Defense (Supply & Logistics); Lieut. Gen. Thomas S. Power, Commander, Air Research and Development Command, Baltimore; George M. Riveire, vice-president, Goodyear Tire & Rubber Company.

Also present were: Hon. George H. Roderick, Assistant Secretary of the Army (Civil-Military Affairs); Brig. Gen. R. L. Scott, Jr., Director, Information Services, United States Air Force; Rear Adm. John H. Sides, Deputy Assistant to the Secretary of Defense for Guided Missiles; Rear Adm. Paul D. Stroop, Deputy Chief, Bureau of Ordnance; Rear Adm. Edmund B. Taylor, Chief of Information, Office, Chief of Naval Operations; Lieut. Gen. Walter L. Weible, Army Deputy Chief of Staff for Personnel; Gen. Thomas D. White, Vice Chief of Staff, U.S.A.F.

Admiral Hussey welcomed the guests, invited all present to attend the Annual A.O.A. Meeting at Aberdeen Proving Ground on Thursday, October 4th, and introduced the guest of honor, Secretary Brucker.

Secretary Brucker reiterated on behalf of the Army the invitation to Aberdeen and paid tribute to the work of the Association. He praised the A.O.A. as a true medium of integration and praised industry for devoting its time in support of the A.O.A., thus greatly enhancing the strength of our national defense.

Secretary Higgins Addresses St. Louis Post on Army Procurement Activities

The present status of procurement activities of the Army was described in detail to the members of the St. Louis Post at its annual meeting on March 15, 1956. The Assistant Secretary of the Army (Logistics), the Honorable Frank H. Higgins, was the speaker and guest of honor at the meeting. More than 500 members and guests were in attendance.

The progress which has been made in the standardization of items and the congressional directives which govern many of the procurement policies as well as the variety of materials dealt in were all vividly portrayed by the Secretary who used charts to describe the size of the operations now, during the Korean campaign, during World War II, and in the preceding era of pacifism in the United States.

Also a guest of honor at the meeting was Maj. Gen. Emerson L. Cummings, Chief of Ordnance of the Army.

The toastmaster at the meeting was Vincent P. Ring, retiring Post president. Under his guidance and that of his fellow officers the Post has enjoyed a most successful year both in membership and in activity. The record continues the long tradition of the past twenty-nine years since the Post was established.

Preceding the Secretary's address the chairman of the nominating committee, Arthur Mummert, president, McQuay-Norris Manufacturing Company, presented the new slate of officers and directors, which was approved by a unanimous vote of the membership.

Maj. Gen. L. J. Sverdrup, elected as Post president, is a well-known leader of American industry and a soldier of renown. He served on the staff of General MacArthur in the Pacific during World War II and is currently chairman of an important advisory committee to the General Staff of the Army. He is president of Sverdrup & Parcel, Inc., engineers of worldwide recognition. The entire roster of new officers and directors is shown in the 1956-1957 Annual Directory that accompanies this issue of ORDNANCE.

Following the election the status and goals of the American Ordnance Association were discussed by Col. Leo A. Codd,

executive vice-president of the A.O.A.

Earlier in the day Secretary Higgins, accompanied by General Cummings, Colonel Codd, Col. William E. Campbell, Jr., aide to the Secretary, and Lieut. Col. Thomas W. De Mint, assistant to General Cummings, visited the St. Louis Ordnance Plant the three prime operators of which are the United States Defense Corporation which is in charge of the ammunition division; McQuay-Norris Manufacturing Company, operator of the core division; and General Motors Chevrolet Motor Division, operator of the shell division of the plant.

The party first visited the shell division which was, until May 1954, producing 105-mm. shells. The division is now in layaway status under a 5-year contract for maintenance with General Motors Corporation. Next the party visited the ammunition division operated by the United States Defense Corporation, a subsidiary of Olin Mathieson Chemical Corporation. This division is in three phases of operation: rehabilitation, production, and layaway.

The core division of the plant was operated by McQuay-Norris Manufacturing Company for the production of caliber .30 and caliber .50 bullet cores until September 1955. Machinery and equipment are in process of being laid away for stand-by maintenance. This entire operation is one of the most significant evidences of determination by the people of the United States to preserve the armament production capacity of the United States.

Like many other plans now in layaway status, the thoroughness of the conditioning and the instant readiness for operations are heartwarming examples that our country has learned the lesson of its folly in dismantling armament-production capacity following the Second World War.

In the afternoon the Secretary and his party were guests of the Emerson Electric Company at one of the company plants where current rocket production is in progress.

Many Puget Sound Post Members Visit Nike Antiaircraft Units and Attend Dinner at Seattle

In Seattle on Thursday, April 26th, the Puget Sound Post turned out in large numbers for a day's outing and dinner meeting. In the afternoon they visited one of the outlying Nike antiaircraft units

Brig. Gen. W. E. Eubank, Jr.

and in the evening gathered in the Boeing Engineering Auditorium for dinner.

Led by Col. Marmion D. Mills, Post president, the members inspected the Midway Nike site manned by Battery D of the 433rd AAA missile battalion which is part of the 26th Antiaircraft Artillery Group commanded by Col. N. A. Skinrood. All hands received a complete briefing on the activities and procedures that take place at a missile emplacement.

From the Midway site the crowd journeyed over to the Boeing Airplane Company where they toured the B-52 assembly line before attending dinner in the plant cafeteria. After the dinner meeting Brig. Gen. W. E. Eubank, Jr., commander, 93rd Bombardment Wing at Castle Air Force Base, spoke on "B-52 Operations." The General's illustrated lecture presented a most thorough briefing in the practical operations of our intercontinental strategic bombers.

It was an extremely well planned day, and the members now look forward to a meeting in August with the Navy on board the aircraft carrier HORNET at the Bremerton Navy Yard.

Cleveland Post Hears General Engler at Dinner in Honor of Army Ordnance Corps Leaders

The Cleveland Post was host to the leaders of Army Ordnance throughout the country at a gala affair at the Hotel Statler on Tuesday, April 3rd. District chiefs and their deputies, arsenal commanders and division directors from Ordnance headquarters in the Pentagon gathered with the distinguished members of the Cleveland Post at their Spring Dinner Meeting.

The dinner meeting followed the first of two days of conferences held simultaneously for all ordnance officials. Post president A. J. Weatherhead, Jr., presided, and J. E. Trainer, Post vice-president, was toastmaster.

This meeting was one of the most sparkling affairs in A.O.A. Post annals. The talks and speeches were sincere and well presented. The audience of over 500 was most attentive and appreciative.

Mr. Trainer led off with an excellent recital of the A.O.A. preamble. Mr. Weatherhead paid tribute to the founders of the Post for their tireless efforts in behalf of the Industry-Ordnance Team.

Ralph M. Besse, chief of the Cleveland Ordnance District and executive vice-president, Cleveland Electric Illuminating Company, and Maj. Gen. Emerson L. Cummings, Chief of Army Ordnance, paid heartfelt tribute to the splendid coöperation and earnest efforts of Ordnance and industry in support of national defense.

Brig. Gen. Jean R. Engler, recently appointed chief of the Industrial Division, Office of the Chief of Army Ordnance, was the principal speaker. He traced military warfare from the inception of cavalry

PRAYER FOR ORDNANCEMEN

"For all His many blessings God's Holy Name be praised—blessings of resources, privileges, and opportunities beyond those enjoyed by any peoples of any nation on the face of the earth.

"Our hearts are grateful for those men who have preceded us, who loyally and bravely preserved our liberty. Grant that we may maintain and pass on to our children this heritage of freedom.

"Strengthen our wills that we may be loyal to Thee, our God, and to our Nation, and ever reveal the ideals for which our Association stands.

"Grant that only the truth may be spoken and only the truth received, inspiring us to be noble and great-hearted citizens and thus an ensign of hope to all who come under our influence. This we ask in Christ's name. Amen."—REV. GEORGE PAULL T. SARGENT, *Rector Emeritus, St. Bartholomew's Church, at the annual meeting of the New Yok Post at the Sheraton-Astor Hotel, New York City, May 8, 1956.*

to the use of gunpowder up through the era of the airplane and nuclear weapons. He noted that even the earliest weapon types are still in use although their designs are modernized frequently.

General Engler denied the "ultimate" weapon. He pointed out the quick countermeasures to each type of "new" weapon such as knights in armor, the tank, and even gas.

The general explained that the Ordnance Corps was streamlining procurement in an all-out fight against time. In the development of new weapons, he said, Ordnance is asking industry to expedite or telescope work. At the same time, industry is being asked to continue to maintain facilities for the production of conventional weapons.

At the head table in addition to those mentioned previously were: Maj. Gen. N. M. Lynde, Jr., Ordnance Tank Automotive Command, Detroit, Mich.; Brig. Gen. R. G. Butler, Ordnance Ammunition Command, Joliet, Ill.; Brig. Gen. H. N. Toftoy, commanding general, Redstone Arsenal, Huntsville, Ala.; Col. J. G. Duncan, III, deputy chief, Cleveland Ordnance District; Col. J. M. Stark, Industrial Division, Office, Chief of Army Ordnance, Washington, D. C.; Lieut. Col. Lawrence M. Wolf, chaplain, 83rd Division; Col. Leo A. Codd, executive vice-president of the American Ordnance Association; Brig. Gen. J. M. Colby, commanding general, Frankford Arsenal, Philadelphia, Pa.; and William I. Ong, director, Cleveland Post.

Yankee Post Members Attend Spring Meeting at Museum of Science, Boston

A representative cross section of New England industry and many men from the armed forces attended the Yankee Post spring meeting on Wednesday, May 2nd, at the Museum of Science, Boston, Mass. This was an especially significant meeting in that it commemorated the Post's thirtieth year of activity—the fifth oldest Post in the Association.

Under Edgar Fain, Post president, there was a full agenda with Mr. Fain personally reading the A.O.A. preamble followed by a brief talk on the Association by Capt. J. M. P. Wright from Washington headquarters who also presented a certificate of appreciation on behalf of the national directors to Charles B. Weeks, previous Post president. Mr. Weeks had given freely of his time to further the goals of the Association and broaden the membership base and lead the Post through a highly successful year of activity.

A special tribute was paid to George P. Slade, legal adviser to the Boston Ordnance District, by Howard P. Richardson, vice-president of First Boston Corporation and a director of the Yankee Post, for his years of outstanding work.

The guest of honor and principal speaker, Maj. Gen. David H. Baker, director of production and procurement, Air Matériel Command, was introduced by Brig. Gen. James McManmon, chairman of the board, Harrington & Richardson, Inc., Worcester, Mass. General Baker discussed the problem of the great need for extreme reliability of missiles and at the same time a rapid absorption into the program of new developments. He explained the effect on operations of small component failures and outlined the many reasons for his demand for reliability.

The general pointed to the great cost per missile, the problem of maintenance in the face of decreasing technical competence of servicemen, and the tremendous stores of spare parts that must be carried in order to assure maximum reliability when the missile is launched.

In addition to those mentioned, also at the speakers' table were: Capt. I. B. Monahan, U.S.N., First Naval District, Boston, Mass.; Capt. W. E. Howard, Jr., Boston Naval Shipyard; Col. Ernest H. Miller, chief, Boston Air Procurement District; Maj. Gen. Raymond C. Maude, commander, Hanscom Field; Howard P. Richardson, Vice-President, First Boston Corporation, Boston, Mass.; Col. A. P. Taber, Watertown Arsenal, Watertown, Mass.

Also at the speakers' table were: Harry A. Wansker, Carr Fastener Company, Cambridge, Mass.; Maj. Martin J. Stein, chaplain, A.R.D.C., Hanscom Field; Carl F. Carlstrom, Carlstrom Pressed Metal Company, Westboro, Mass.; Paul Sibley, Worcester Taper Pin Company, Worcester, Mass.; William H. Buracker, Jackson & Moreland, Boston, Mass.; David Gilman, Eastern Fixture Company, Boston, Mass.

Likewise at the head table were: Helge Holst, treasurer, Arthur D. Little, Inc., Cambridge, Mass.; Charles C. Bell, vice-president, Universal Winding Company, Providence, R. I.; Chenery Salmon, vice-president, Merchants National Bank, Boston, Mass.; Col. John S. Pfeil, vice-president, Stone & Webster Engineering Corporation, Boston, Mass.; Col. Joshua A. Finkel, Huntington Woods, Mich.; James J. Murphy, Boston Ordnance District; John K. Ames, Burrowes Corporation, Portland, Me; and Lieut. Col. Gilbert Dubia, Boston Ordnance District.

At Yankee Post meeting Maj. Gen. D. H. Baker, U.S.A.F., center, principal speaker, chats with J. Edgar Fain, left, Post president, and Brig. Gen. James McManmon.

Quad Cities-Iowa Post Visits Bendix Plant, Sees Atomic Power Film, Attends Dinner

A memorable spring gathering of the Quad Cities-Iowa Post was held on May 4th that included a visit to the Pioneer Central Division of Bendix Aviation Corporation in Davenport, a special film on atomic power reactors, and a dinner meeting at the Rock Island Arsenal.

At Bendix, members witnessed production testing and demonstrations of instruments and oxygen breathing apparatus used in military aircraft. They were especially impressed with the ultrasonic cleaning equipment used on parts prior to assembly.

Presiding officer at the dinner meeting, Post President Maurice A. Fraher, Deere & Company, opened the program with a splendid rendition of the A.O.A. preamble. He then introduced guests at the head table who in turn greeted the members and paid tribute to the Association.

its loyal support of national defense, and the splendid coöperation locally of the Post officers and members in ordnance affairs.

The guests who spoke were Col. A. R. Cyr, commanding officer, Rock Island Arsenal; Brig. Gen. T. A. Weyher, commanding general, Ordnance Weapons Command; Capt. J. M. P. Wright, American Ordnance Association; and N. F. Hosford, chief engineer, Pioneer Central Division, Bendix Aviation Corporation.

Donald Meyers of Rock Island Arsenal, Post secretary-treasurer, who has served the Post loyally and with great ability for many years, reported on activities and financial affairs of the Post for the past year.

The speaker of the evening, Dr. Donald N. Gardiner, chief of the biology branch, Atomic Energy Commission, presented a wealth of information in his talk "Peaceful Applications of Atomic Energy, Research, and Industrial Development." Among the numerous areas he covered were the usefulness of small transportable atomic power plants, the preservation of foods by radioactivity, the mutation of agricultural products to improve yields, and the utilization of radioactivity to control production-line dimensions.

Dr. Gardiner also discussed the unsolved problem of disposal of waste radioactivity material. He also emphasized that although uranium was cheaper as a source of energy, the complexity of safe handling and controlled fissioning of uranium made the final present cost of producing power by this means excessive in a country as rich as ours in coal.

On the day of this meeting the Post's board of directors met at luncheon where Mr. Fraher was nominated as the national Council representative.

Louisiana Post Splits Annual Meeting between Fort Polk and Barksdale AFB

The members of the Louisiana Post cut a wide swath through the state on their annual meeting day—Tuesday April 9th. Traveling 140 miles south from Shreveport, the ordnance devotees witnessed demonstrations and exhibits at Fort Polk then returned to Barksdale Air Force Base north of Shreveport for the dinner meeting at the Officers' Club.

The 1st Armored Division, commanded by Maj. Gen. Robert Lee Howze, was host for the day in a well-coördinated schedule that included a briefing by Col. G. F. Rogers, commander, Combat Command B, inspection of the ordnance and vehicle maintenance shops, Army-style lunch at noon, and an afternoon of firepower demonstrations. Every weapon and one or more examples of each type of combat vehicle used by the 1st Armored Division were put through their paces and then employed in a combat exercise.

While infantry platoons on foot and in armored personnel carriers moved forward, the "enemy" positions were taken under fire by M48 tanks and self-propelled 105-mm. howitzers. Helicopters assisted in observation and removing the "wounded." Realistic combat conditions were enhanced by intermittent rain and a sea of mud.

At the Barksdale Officers' Club the assemblage was increased by the arrival of members from Red River Arsenal, the Naval Ordnance Plant at Camden, Ark., and local Air Force personnel who had missed the Fort Polk trip.

After a social hour and dinner, Post President James Ward presided at a brief business session, opened by a recital of the A.O.A. preamble and closed by the unanimous election of officers and directors for the ensuing year.

Toastmaster Wesley T. Leeper, vice-president, Bayou State Oil Corporation, and a leading citizen of Shreveport, welcomed the members and introduced the distinguished guests after paying tribute to the hospitality of the 1st Armored Division and the Air Force at Barksdale. Capt. J. M. P. Wright, U.S.N., Ret., delivered a message from A.O.A. headquarters.

Lieut. Gen. Leslie R. Groves, wartime commander of the Manhatan District development agency for the atomic bomb, was guest of honor and principal speaker. He had participated in the activities at Polk and pointed to the events of the day as a fitting example of the need for "superior research for superior ordnance."

General Groves drew on his vast experience in the Army to emphasize his thesis that the military must define the specifications for their weapons and then look to the research and development personnel to find the answers. He expressed the belief that nuclear weapons have made war unprofitable but that this Nation must keep strong through research or an enemy would find it profitable to attack us.

Others among the distinguished guests were Maj. Gen. George W. Mundy, deputy commander, Second Air Force; Capt. John A. Edwards, commander, Shumaker Naval Ordnance Plant; and Col. James White, commander, Barksdale Air Force Base.

• **AT ALBUQUERQUE.**—The local Post met on the evening of Thursday, April 5th at the University of New Mexico to hear F. J. Given of Sandia Corporation talk on "Problems of Future Research." Col. C. F. H. Begg, president of the Post, presided, ably assisted by the officers and directors.

Mr. Given, who is vice-president in charge of research and development services, started with the Western Electric Company in 1919. He stressed especially the problem of reliability of guided missiles. He pointed to the urgent need for exceptionally high reliability because of the great expense of each missile and the shortage of skilled technical men to make adjustments and tests in the field.

Hartford-Springfield Post Joins A.O.A. Division for Meeting at Springfield

Members of the Hartford-Springfield Post joined with their associates of the Small Arms and Small Arms Ammunition Division to hold their annual meeting on Thursday, May 3rd, at the Sheraton-Kimball Hotel, Springfield, Mass.

The meeting was called to order by Post President Stanley C. Hope who presented Lieut. Col. William F. Taylor, Air Force Chaplain, to deliver the invocation. After the dinner Mr. Hope introduced the guests of honor and called on Col. Leo A. Codd, executive vice-president of the Association, who paid tribute to the leaders of the Post and the Small Arms Committee for their loyal support of the armament needs of our national defense. He also read the preamble to the A.O.A. constitution.

Frederick F. Hickey, chairman of the Small Arms and Small Arms Ammunition Division, added his thanks to those of Mr. Hope for the interest and support given by the members.

Maj. Gen. E. P. Mechling, commander, Air Force Armament Center, Eglin Air Force Base, Fla., the guest of honor, spoke on the significance of research in the struggle to maintain a superior Air Force. He listed new material now in operation that has stemmed from earlier research.

General Mechling explained the Air Force's program to develop many futur-

Post President Stanley C. Hope, center, felicitates Maj. Gen. E. P. Mechling, right, principal speaker, as Brig. Gen. D. A. Burchinal looks on.

istic components ready to be incorporated into a weapons system. He expressed the hope that by good management and by taking industry into its confidence the Air Research and Development Command would be able to maintain the technical superiority of all Air Force armament.

Guests at the head table were: Col. Douglas G. Ludlam, commanding officer, Springfield Armory, Springfield, Mass.; Benjamin B. Mathis, chief, Springfield Ordnance District; D. G. Millar, director, Hartford-Springfield Post, A.O.A.; John S. Begley, former chief, Springfield Ordnance District; Brig. Gen. Thomas K. Vincent, staff consultant, Technical Divisions and Committees, A.O.A.; Maj. Gen. Russell L. Maxwell, president, New York Post; Maxwell R. Warden, deputy chairman, Small Arms and Small Arms Ammunition Division, A.O.A.

Also at the speakers' table were: Maj. Gen. Walter C. Sweeney, Jr., deputy commander, Eighth Air Force; Charles K. Davis, Post director; Dr. Egbert C. Hadley, executive board, Small Arms and Small Arms Ammunition Division, A.O.A.; Capt. J. M. P. Wright, staff consultant for local Posts, A.O.A.; Carl R. Hellstrom, Post director; James R. Weaver, Post director; Col. Maurice L. Driscoll, deputy chief, Springfield Ordnance District, Springfield, Mass.

Michigan Post Sponsors Procurement Conference and Dinner at Detroit

The Michigan Post presented a unique program on April 11, 1956, with an Army Industrial Procurement Conference followed by the spring dinner meeting at Detroit. The guest of honor, conductor of the conference, and speaker at the dinner meeting was the Hon. Frank H. Higgins, Assistant Secretary of the Army (Logistics). He was accompanied by six members of his staff—each an expert on various phases of procurement policy.

Col. Herbert R. White, president of the Michigan Post and president of Eclipse Counterbore Company, presided at the conference which was held in the late afternoon with more than 400 members and guests of the Post in attendance. Nearly 600 were present at the dinner.

Secretary Higgins had as his members of the panel: Maj. Gen. Henry R. Westphalinger, Brig. Gen. Jean E. Engler, Col. William H. Gurnee, Jr., Col. N. R. Voorhis, and Jack W. Askins. Lieut. Col. William E. Campbell, Jr., and Maj. James C. Larson assisted the panel.

The topics for forum discussion were: (1) advertised contracts, (2) negotiated contracts, (3) open-end and call-type contracts, (4) research and development contracts, (5) all other type contracts, (6) preaward matters, and (7) open discussion covering Army procurement.

There was an animated question-and-answer period in which the audience participated following the presentation of each major topic.

The general consensus was that the discussions were most informative and timely. On all sides there were expressions of admiration for the superb leadership of Secretary Higgins and the capabilities of the members of his staff.

At the dinner meeting the Secretary spoke on the general procurement problems of the Army. Using charts, he stressed the variety of items delt with, the huge quantities involved, the changing need for various types, and the always-difficult question of inventory and surplus disposal.

Malcolm P. Ferguson, president of Bendix Aviation Corporation and member of the Advisory Committee of the Michigan Post, responded for industry to the Secretary's remarks:

"After hearing the interesting address of Mr. Higgins tonight," he said, "I am sure that I express the sentiments of every one here when I say that I am more than ever tremendously impressed by the Army program. As we learned in Korea only a few short years ago, the United States Army must be ready to do the actual front-line fighting when a conflict starts. Fortunately for all of us, our Army today is a well-trained, efficient force of men and weapons upon which the country can and does rely.

"Reading about hydrogen bombs and intercontinental ballistic missiles we sometimes tend to forget the fundamental importance of the Army itself in maintaining peace and order throughout the world. It is a mighty organization in which its splendid officers can well take great pride. . . .

"For many years the word 'ordnance' has stood for the massive, the powerful, the devastating machines of war of every description from bullets to tank retrievers, and until recently it was inevitable that modern ordnance should be thought of as almost interchangeable with the characteristic output of Detroit's automotive industry. In the aggregate were many vehicles comprising modified standard vehicles, specialized Ordnance vehicles, and tanks. But there were also guns of all sizes, ammunition, and engines.

"In the last war, Detroit demonstrated that with lightning speed it could convert from the production of cars and trucks and their components to the production of those Ordnance items which depended upon the strength and the mobility of steel powered by mighty engines. . . Ordnance today is changing, and it will be even more different tomorrow."

At the speakers' table were the following members and guests: Lieut. Col. H. B. Calahan, commanding officer, Marine Air Detachment, Grosse Ile; Charles W. Brownell, National Bank of Detroit, secretary-treasurer, Michigan Post; Thomas Couper, L. A. Young Spring & Wire Corporation, Post director; Britton L. Gordon, Blackmer Pump Company, Grand Rapids, Mich., Post director; Mr. Askins; Col. Arthur C. Nauman, district chief, Corps of Engineers; Harold R. Boyer, Cadillac Tank Plant, past director, Michigan Post.

Also at the speakers' table were: Col. Edward D. Mohlere, commanding officer,

Detroit Ordnance District; Raymond R. Eppert, Burroughs Corporation, director, Michigan Post; Col. L. A. Codd, executive vice-president, American Ordnance Association, Washington, D. C.; Louis E. Moultane, McLouth Steel Corporation, Post director and chairman of this year's membership committee; Henry Tuttle, Michigan Consolidated Gas Company, director, Michigan Post; Brouwer D. McIntyre, Monroe Auto Equipment Company, member, Post advisory committee; Colonel Voorhis; C. Jack Reese, Continental Motors Corporation, member, advisory committee, Michigan Post; General Engler; Rev. J. A. Visser, chaplain, Westminster Church of Detroit.

Likewise at the head table were: Maj. Gen. Nelson M. Lynde, Jr., commanding general, Ordnance Tank Automotive Command, member, advisory committee, Michigan Post; Secretary Higgins; Thomas F. Morrow, Chrysler Corporation, director, Michigan Post; Gordon B. Bonfield, American Box Board Company, Filer City, director, Michigan Post; Col. Norman S. Orwat, base commander, Selfridge Field; J. Frank Forster, Vickers Inc., Post director.

Also among the guests of honor were: Col. Roger H. Hemion, commanding officer, Detroit Arsenal; Fred W. Parker, Jr., Timken-Detroit Axle Company, director and chairman of the Post's activities committee; Capt. E. W. Yancey, inspector, Navy material; Henry T. Bodman, National Bank of Detroit, past president, Michigan Post; Colonel Gurnee; Irving A. Duffy, Ford Motor Company, national Council member at large; General Westphalinger; Mr. Ferguson; Colonel Campbell; and Major Larson.

New York Post Elects General Groves, Hears General O'Connor, at May Meeting

The New York Post held its annual meeting on Tuesday, May 8th at the Sheraton-Astor Hotel, New York City.

The meeting was opened by an appropriate and stirring invocation delivered by the Reverend Dr. George P. T. Sargent. After dinner Maj. Gen. Russell L. Maxwell, president of the Post, called on Howard E. Isham as chairman of the nominating committee to announce the proposed slate for the ensuing two years.

The new slate headed by Lieut. Gen. Leslie R. Groves, vice-president, Sperry Rand Corporation, as Post president, was voted unanimously by the members. A complete list of the officers and directors appears in the Annual Directory that accompanies this issue.

General Maxwell thanked the members for their unfailing support during his term of office and paid special tribute to the great work done by Col. Lloyd W. Stearns for his labors as chairman of the Program Committee and the excellent arrangements that he had made for all A.O.A. events.

Maj. Gen. Robert E. Condon, Director of New York City Civil Defense, delivered a message from Bernard Baruch, the famous American financier: "Mr. Baruch regretted that he could only be with you for the reception. He wanted the members to know that he was happy to see that the A.O.A. was doing so well and so much for national defense."

The president of the American Ordnance Association, Vice Adm. George F. Hussey, Jr., complimented the Post for the high caliber of its programs and its achievement in increasing its membership so that New York is now largest Post in the organization. For this outstanding record Admiral Hussey praised General Maxwell and closed in presenting to the general a specially inscribed certificate of appreciation from the national directors of the A.O.A.

The guest speaker, Brig. Gen. W. W. O'Connor, deputy to the Special Assistant for Reserve Components, Office of the Chief of Staff, delivered a most illuminating address on industry's part in the Army Reserve Program. The General explained the many advantages both to our youths and American industry if our young men would become members of the Reserve early in their careers. He emphasized that the Army would make arrangements for men to complete their education if they signed up sufficiently in advance. The Reserve plan also is designed to help industry by reducing the time its most skilled people will have to serve.

At the speakers' table were: Chester Mueller, vice-president, New York Post; Capt. J. M. P. Wright, staff consultant, Post operations, A.O.A.; Brig. Gen. Edgar T. Conley, chief, New York Military District; Howard E. Isham, vice-president, New York Post; Brig. Gen. Robert E. Condon, U.S.A.F.R., director, New York City Office of Civil Defense; W. J. R. Overath, regional representative, Bureau of Veterans' Reemployment Rights, United States Department of Labor, Washington, D. C.; Hartley W. Barclay, vice-president, New York Post; A. E. van Cleve, vice-president, New York Post; Col. Paul Steinbeck, chief, New Jersey Military District; Lieut. Col. John W. Graham, secretary-treasurer, New York Post.

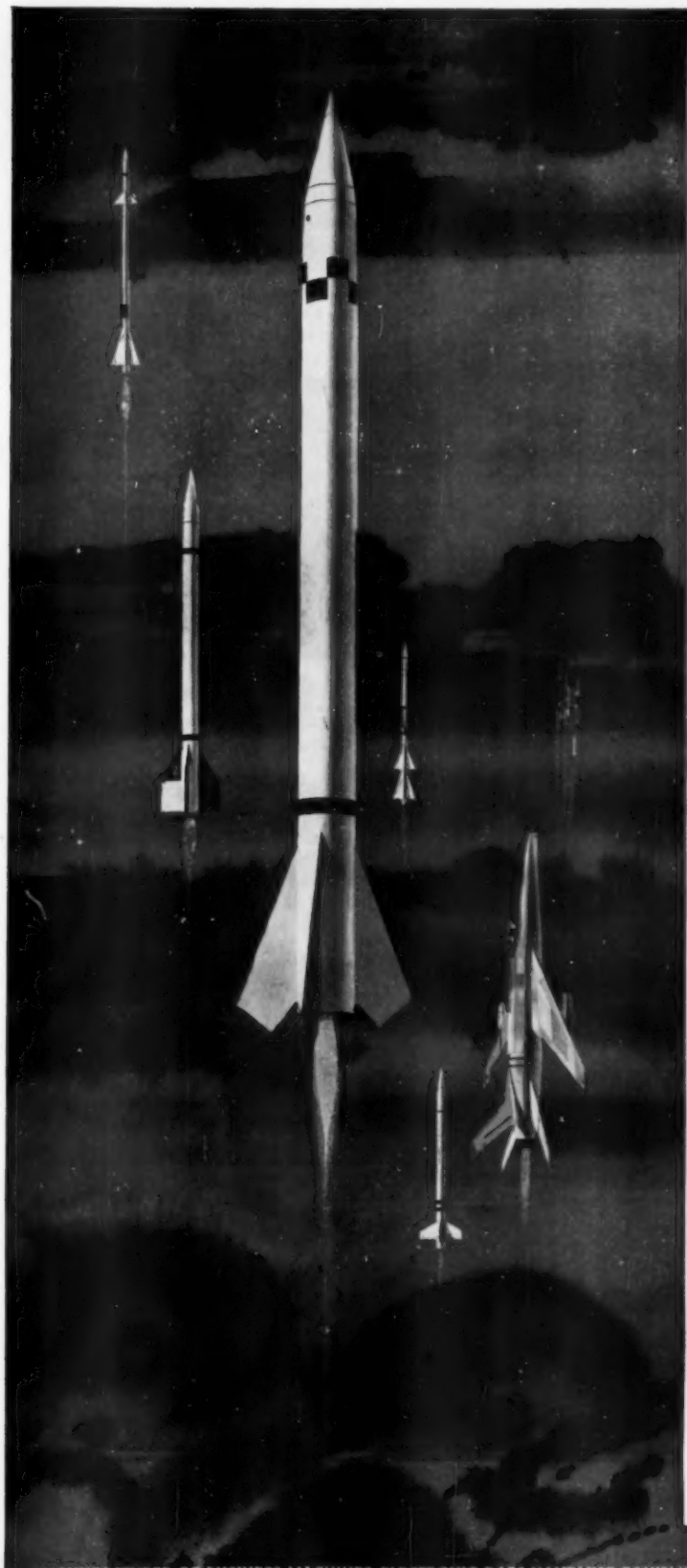
Left to right: Maj. Gen. R. L. Maxwell, retiring Post president; Lieut. Gen. L. R. Groves, new president; Bernard Baruch; Vice Adm. G. F. Hussey, Jr., A.O.A. president.

A.O.A. Bomb Committee and the Florida Post Hold Joint Meeting at Eglin Air Force Base, Fla.

Maj. Gen. Edward P. Mechling, commander of the Air Force Armament Center, Eglin Air Force Base, Fla., served in the dual capacity as host to two units of the Ordnance Association on April 17-18, 1956, when the Association's Bomb Committee and Florida Post met there.

The Committee, under the chairmanship of N. L. Etten, Chamberlain Corporation, Waterloo, Iowa, met during April 17th and 18th. The Post members joined with members of the Committee at a dinner meeting on the evening of the 17th. The sessions of the Committee meeting were held at Andrews Engineering Building on the base.

The dinner meeting was held at the Officers' Club. At the latter, General Mechling as toastmaster introduced the speakers who were Mr. Etten and Col. L. A. Codd, executive vice-president, Ameri-



THE SKY IS FULL OF VITAL CLARY CONTROLS

...in missiles, rockets and aircraft!

LIKE SO MANY missile developers, the designers of the Firestone "Corporal," the North American "Navaho," and four other classified missiles, specified *Clary* for vital automatic controls. Every control that bears the Clary name combines delicate precision (up to seven-one-millionths of an inch tolerance) with bulldog construction and supreme reliability. Our long experience in manufacturing to the stringent requirements of missiles also gives us an outstanding background in producing vital rocket and aircraft components... for air-to-air rockets, jet engine after-burner actuators, fuel system emergency valves and others that cannot be named.

WE INVITE YOU to come to Clary, where our expanding engineering and manufacturing facilities provide you with—

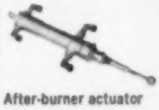
- ▶ DESIGNING AND TESTING to established specifications and envelope drawings.
- ▶ PRODUCTION-ENGINEERING of parts or complete components covered by your prototype sketches or drawings.
- ▶ MANUFACTURING of precision components to established drawings and specifications.

TYPICAL CLARY AUTOMATIC CONTROLS

Servo actuator for the "Corporal"

Gate-type propellant valve for the "Navaho"

Gyroscope for the "Corporal"



After-burner actuator for jet engines

Clary

AUTOMATIC CONTROLS DIVISION

CLARY CORPORATION

Dept. NA76, San Gabriel, Calif.

MANUFACTURER OF BUSINESS MACHINES ELECTRONIC DATA-HANDLING EQUIPMENT AND AIRCRAFT AND MISSILE COMPONENTS

can Ordnance Association, Washington, D. C.

Col. Henry B. Kucheman, Post president, was in general charge of the meeting and presided at the dinner. He was assisted by other officers and directors of the Post. The attendance at dinner was the largest in the history of the Post.

A full report of the Committee meeting is given on page 82.

• **AT SYRACUSE.**—The Syracuse-Central New York Chapter of the Empire Post turned out with a record 250 members on May 10th to welcome Senator George W. Malone as guest of honor at the annual dinner meeting.

The crowd gathered early at the Hotel Onondaga for the reception. Following the dinner the Senator delighted his audience with a stirring address on "The American System Versus International Socialism." He emphasized the need for giving "the American system full support" in its international competitive position and, to ensure that this Nation is adequately defended, advocated extending our defense area as far as necessary for ultimate safety.

"We will have peace when we have again sounded the warning to the nations of the world that liberty and economic freedom are our continuing objectives—and that we are prepared to protect them," he said.

College R.O.T.C. Units Award A.O.A. Scholarship Keys to Outstanding Ordnance Cadets

Each year the honor Ordnance cadets in the R.O.T.C. units in colleges throughout the country are awarded the American Ordnance Association Scholarship Key and a year's membership in the Association. These awards recently were made at the following institutions:

University of California.—Cadet B. F. Greschel, Albany, Calif., is majoring in industrial management in the School of Business Administration. He is a member of the National Society of Scabbard and Blade.

H. W. Babel James Nesmith, III

Cornell University.—Cadet Maj. James Nesmith, III, Garden City, N. Y., is majoring in mechanical engineering and is a member of the American Society of Mechanical Engineers.

University of Detroit.—Cadet Marion J. Balcerzak, Baltimore, Md., is majoring in engineering, and at the university he has risen to the second highest cadet office, regimental executive officer.

M. J. Balcerzak B. F. Greschel

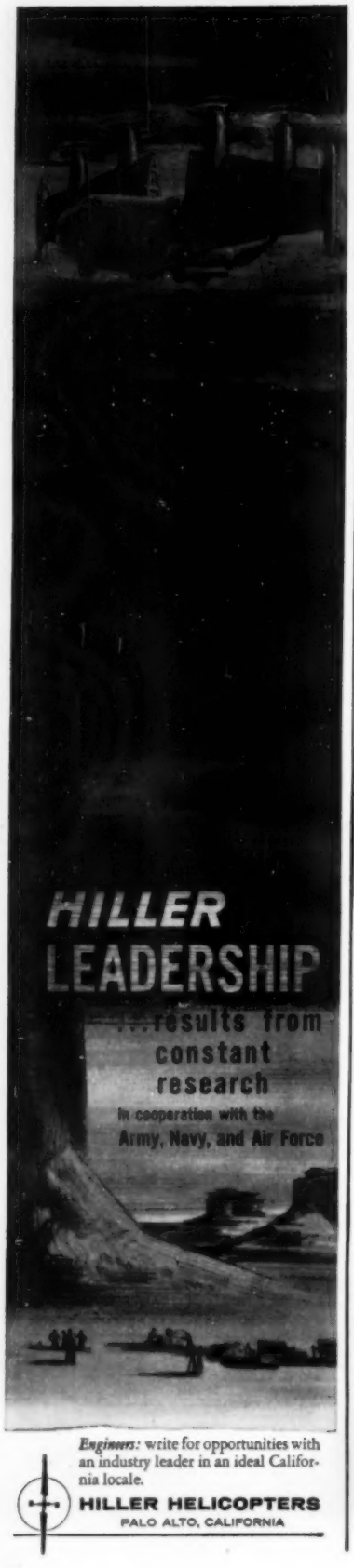
Georgia Institute of Technology.—Cadet Lieut. Col. Albert F. Gandy, Hartsville, S. C., is majoring in industrial engineering and is cadet commander of the ordnance battalion and a member of American Institute of Industrial Engineers.

Gonzaga University.—Cadet Capt. Richard Earl Cook, Spokane, Wash., was a senior in the School of Electrical Engineering and was commissioned a second lieutenant in the Ordnance Corps upon completion of the present academic school year.

C. P. Sitkin A. F. Gandy

University of Illinois.—Cadet Henry W. Babel, Champaign, Ill., received a degree in mechanical engineering and completed his undergraduate work in August 1955. He is presently instructing in various production courses in mechanical engineering and working for an advanced degree.

Lafayette College.—Cadet Charles P. Sitkin, Arlington, Va., is majoring in industrial engineering and is a member of the Scabbard and Blade Society. He was


HILLER
LEADERSHIP
...results from constant research
In cooperation with the Army, Navy, and Air Force
Engineers: write for opportunities with an industry leader in an ideal California locale.
HILLER HELICOPTERS
PALO ALTO, CALIFORNIA

BERMITE MISSILE TRACKING FLARES

Lead All Others!

Now in operation, Bermite Missile Tracking Flares lead all others in accurate, trouble-free, dependability. They are being supplied to Hughes Aircraft, Glenn L. Martin Company and many others.

Rugged, shock-resistant construction, Bermite tracking flares also lead in all-around performance.

Burning Time 30 Seconds • Maximum Candlepower 300,000
Initiates at Mach 1 • Squib Ignition
Sustains Burning at Mach 2.2 • Weight 1 lb.
Length 10″, Diameter 1¾″

Other Bermite tracking flares include a unit 3″ long, 1¾″ diameter, with parasitic ignition. Also under development are mono-chromatic missile tracking devices in sodium D, reds and infra-red, with operating altitudes in excess of 60,000 ft.

• *Bermite Built Ordnance Is Better Built . . .*
Through Production, Research and Development

BERMITE *Bermite Powder Company*

MINT CANYON ROAD, SAUGUS, CALIFORNIA

MAGNETIC METALS COMPANY

For magnetic amplifier core applications

Centricores

. . . toroidal wrapped magnetic cores of high permeability alloys which include materials with high squareness ratio and low coercivity, or high initial permeability. Active types are carried in stock. Test methods and engineering data are presented in Magnetic Amplifier Core Bulletins.

Stamped Rings

. . . laminations which exhibit highest obtainable physical, thermal, mechanical and magnetic stability. Such rings can be stamped as thin as .004". *Write for Bulletin C1.*

DU Laminations

. . . stampings which permit production use of economical pre-wound coils and provide uniformity of magnetic amplifier performance. *Write for Bulletin D1.*

MAGNETIC METALS COMPANY
21st & HAYES AVENUE • CAMDEN, N.J.

Electromagnetic Cores and Shields

Association Affairs (Contd.)

R.O.T.C. Medalists

named as a distinguished military student.

Massachusetts Institute of Technology.—Cadet Maj. Julio B. Arroyo, Jr., New York City, was presented the scholarship key at the awards ceremony on May 8,

J. M. Greig **D. M. Buckbee**

1956. He is majoring in business and engineering administration. For the past year he has been an officer of the M.I.T. Post of the American Ordnance Association.

University of Minnesota.—Cadet 1st Lieut. John M. Greig, Estherville, Iowa, is majoring in business and his field of interest is small arms. He was commissioned in Ordnance this June.

Pennsylvania State University.—Cadet Maj. Donald M. Buckbee, University Park, Pa., was a senior in the electrical engineering curriculum and was commissioned in Ordnance upon graduation. He was the adjutant of the cadet regiment at the university.

• **DANIEL COWAN JACKLING**, renowned mining engineer and director of Army Ordnance explosive plants during the First World War, died at his home, Woodside, San Mateo County, Calif., on March 13, 1956. His offices were in San Francisco.

During the First World War Mr. Jackling, who had served for many years in the National Guard of Colorado and later of Utah, became director of explosives plants and assisted in the building and operation of the high-explosive facilities at Nitro, W. Va. In 1918 he served as assistant to the director of the Purchases, Storage, and Traffic Division of the Army in Washington.

Mr. Jackling received his science and engineering degrees from the Missouri School of Mines at Rolla, Mo. He began his professional career as a chemist and metallurgist of the Cripple Creek District of Colorado and soon became a prominent corporation executive with the Utah Copper Company, Alaska Gold Mines Com-

PATTERN OF A PRODUCTIVE WORK LIFE

This CAT* D8 Tractor has been on the job six years, seven days a week around the calendar, for Metropolitan Edison Co., Reading, Pa. Last year it handled coal from approximately 9000 cars. Shown here reclaiming at the Titus Station, the D8 is also used to feed the hopper. It can handle 200 tons an hour.

How does a Caterpillar D8 Tractor achieve this productive work life? Through rugged simplicity of construction and traditionally honest Caterpillar workmanship. Through ease of maintenance, and easy handling that makes operators *like* the machine. And through such features as highly effective filters and seals that keep lubricants in and grit out of moving parts, and tough, four-cycle diesel engine with aluminum alloy bearings and "Hi-Electro" hardened crankshaft journals and cylinder liners.

Now there is a new Caterpillar D8 Tractor, built to do even *more* work over a *longer* time at *lower* cost than ever before. The new D8 (Series D with torque converter, Series E with exclusive oil clutch drive) has an entirely new 191 HP Caterpillar Diesel Engine. New seven-roller track frame and "water-quench" hardened track shoes give even longer work life. Hydraulically boosted steering, "in-seat" starting and superb visibility make operators cheer louder than ever for the new D8.

The new D8 is available with Caterpillar No. 8U Bulldozer blade for big capacity with little end spillage. Ideally suited for coal-pile work, the D8 weighs 40,000 pounds or more (depending on equipment) and presses coal firmly into place for good compaction.

Your Caterpillar Dealer has all the facts on the new Cat D8 Tractor with No. 8U Bulldozer or other attachments to suit your job. See him today for an on-the-job demonstration—and count on him for skilled service and parts you can trust.

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pany, Mesabi Iron Company, Kennecott Copper Corporation, and others.

He resigned from most directorships in 1942, but remained president of the Mesabi Iron Company until 1943 when he was elected chairman of the board of directors. In 1904 he was awarded the Active Service Gold Medal of the Colorado State National Guard.

He is universally accredited as having been the first to recognize and exemplify the economic potentialities of comparatively low grade copper sulphide ore deposits which now produce fully two-thirds of the total newly mined copper output of the United States. He was awarded the Distinguished Service Medal in 1919 for his service to the Army in the First World War.—L.A.C.

• **MAJ. GEN. FLOYD B. WOOD,** Deputy Commander, Air Research and Development Command, was killed in a jet aircraft accident at Friendship, Md., on April 3, 1956.

General Wood was one of the outstanding Air Force officers in the scientific field especially in aërology and meteorology. He had been most generous of his time in meeting with A.O.A. Posts and Technical Committees to keep them aware of Air Force developments.

Shortly after graduating from North Texas State Teachers' College, the general was appointed a flying cadet in 1928 and was commissioned a year later. In 1937 he received an M.S. degree in meteorology from Massachusetts Institute of Technology.

He served at Air Corps headquarters during World War II and thereafter on the Joint Brazil U. S. Military Commission. Since 1947 he had been closely allied with Air Force research and development at the Wright-Patterson Air Force Development Center and at ARDC headquarters in Baltimore.

Industry and the A.O.A. have lost a good friend who was always helpful and patient in explaining how to convert Air Force requirements into effective items of equipment.

• **KEITH WILLIAMS,** who served for over ten years as an officer or director of the Empire Post, died at his home in Buffalo, N. Y., on February 15, 1956. He was general manager of the Pratt & Letchworth Division of Dayton Malleable Iron Company and a vice-president of the parent company.

Mr. Williams served as a lieutenant in the Navy in ordnance duties during World War I and joined Pratt and Letchworth in 1926.

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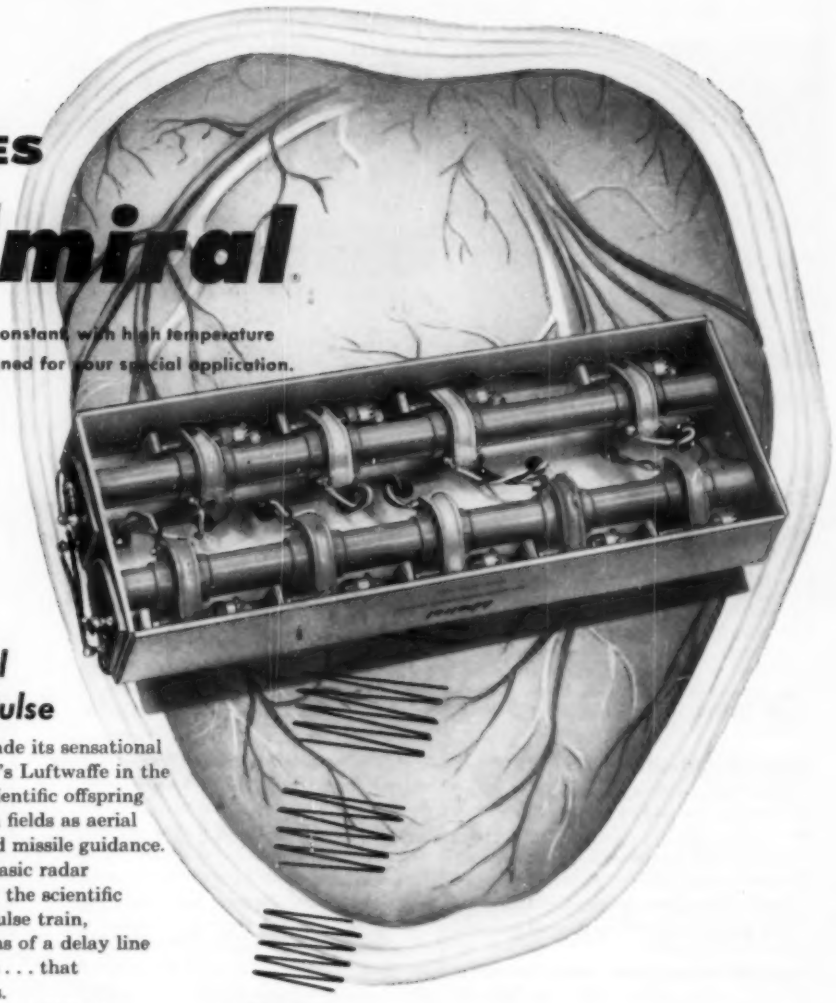


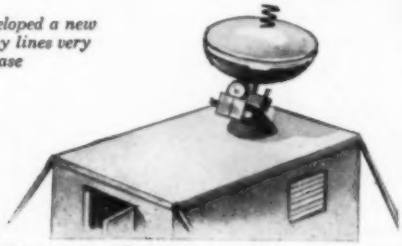
Micro-second Control for an Electronic Pulse

Scarcely fifteen years ago radar made its sensational debut when it helped defeat Hitler's Luftwaffe in the Battle of Britain. Since then its scientific offspring have become commonplace in such fields as aerial navigation, interrogation (IFF) and missile guidance.

All these elaborations of the basic radar principle, and many others now on the scientific horizon, depend on an electronic pulse train, established and controlled by means of a delay line . . . the very *heart* of the apparatus . . . that determines its scope and usefulness.

There was pressing need for a *variable** delay line, self-contained, with utmost accuracy and stability. Now Admiral research has developed such a unit. Where the flexibility of fixed delay lines is limited by the number of taps, the Admiral unit is *infinitely variable* within its overall capacity. It is adjustable with the greatest of ease for any desired interval . . . *without auxiliary circuitry.* Accuracy is limited only by the accuracy of the measuring equipment. Stability is maintained over an extreme temperature range. These delay lines, completely self-contained, including switching apparatus, are much lighter, more compact, and cost far less to make. Write Admiral about designing a delay line for your special application.

**Admiral research has also developed a new procedure for making fixed delay lines very much smaller, with excellent phase characteristics.*



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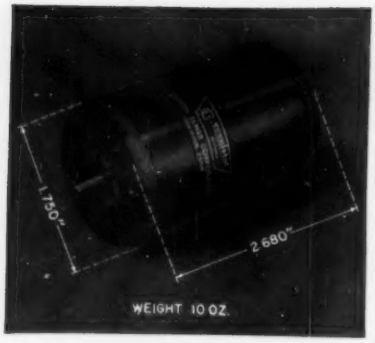

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- **high linearity,** inherent in the design principle, is *maintained* over the life of the unit.
- **low output impedance** eliminates need for isolation amplifiers in many applications.
- **high output current capability.**
- **low phase shift** – less than 90 seconds, depending on model.
- **can be coupled with synchros,** resolvers and other components – as well as ganged.
- **nonlinear functions can also be generated.**

Class 5 ball bearings, centerless ground shaft, and an aluminum housing machined to close tolerances combine to make the Vernistat a precision instrument. Shaft seals will be supplied where they are required by environmental conditions.

check these specifications:

Linearity Tolerance ..... ±0.05%
Minimum Output Voltage Increment 0.01%
Output Impedance.. less than 130 ohms
Input Voltage..... 130 v max.
Input Impedance.... up to 75,000 ohms

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Surface Preservation Committee Holds Nineteenth Meeting at Detroit, Mich.

The nineteenth meeting of the Surface Preservation Committee of the Advisory, Technical and Research Group was held at the Sheraton-Cadillac Hotel, Detroit, Mich., April 10, 1956.

Dr. G. W. Seagren, Mellon Institute of Industrial Research, (Stoner-Mudge), is the chairman of this Committee, and Dr. Myron B. Diggin, Hanson-Van Winkle-Munning Company, is secretary.

About thirty members and guests were present. Two members of the Committee, James McElgin, E. F. Houghton & Company, and Edward H. Engelke, Office, Chief of Army Ordnance, had died since the last meeting, and their loss was appropriately recorded in the minutes.

The technical sessions included a general discussion of phosphate coating specifications. A. G. Tomassetti, Frankford Arsenal, reported on premature cook-off in small-arms ammunition. He also discussed the application of Teflon suspensions for small-arms ammunition, covering surface treatment prior to Teflon coating, spraying, drying, and fusing.

H. F. Davidson, Navy Bureau of Ordnance, concurred in this report and stated that the Frankford Arsenal results were substantiated by Bureau tests. He cited Navord OD 10362 entitled "Process of Applying Polytetrafluorethylene Coatings on Steel Surfaces" issued January 11, 1956, copies of which may be obtained from the Superintendent, U. S. Naval Gun Factory, Washington 25, D. C.

Mr. Tomassetti gave a short report on the use of hot-spray lacquer (MIL-L-11195 and MIL-E-10687). Mr. Davidson, Navy Bureau of Ordnance, reported on the limitations of JAN-P-450, paints, acid-proof, black (for ammunition), and the progress being made on a substitute. He also reported on the progress being made in preparing specifications to replace AXS-829 relating to coating of terne and tin plate.

Dr. M. B. Diggin, Hanson-Van Winkle-Munning Company, reported on the American Electroplaters' Society research project on insoluble anodes.

Dr. Seagren reported on the proposal to change the thickness specifications for electroplating and planned to pursue this further.

High-temperature coatings were discussed in answer to an inquiry from the Food and Container Institute in Chicago.

J. L. Flynt, Ordnance Ammunition Command, presented a new problem, calling for a coating for the interior of empty chemical shells during shipment. Lloyd Gilbert, Rock Island Arsenal, gave a short talk on alkaline derusting.

The next meeting of this Committee, its twentieth, will be held at Frankford Arsenal on October 3, 1956, when new officers will be elected. This meeting date is the day before the Annual A.O.A. National Meeting at Aberdeen Proving Ground.

Underwater Division of the Association Holds Meeting at U. S. Naval Base, Key West, Fla.

The Underwater Ordnance Division, with its three Committees, met at the U. S. Naval Base, Key West, Fla., March 29-30, 1956. Adm. A. G. Noble, Vitro Corporation of America, is chairman of this Division.

The Mine Committee, Underwater Ordnance Division, met on March 28th at the U. S. Naval Minecraft Base, Charleston, S. C., under Chairman J. McW. Stone, Dukane Corporation. This was a classified meeting in which the Committee discussed pertinent mine problems. This Committee joined the Torpedo Committee, Dr. G. R. Tatum, Vitro Corporation of America, chairman, and the Fire Control Committee, Lewis W. Imm, Libracope, Inc., chairman, for the 2-day classified Division meeting at Key West which has become an annual affair for this Division.

Bomb Committee Visits Air Force Armament Center, Fla., for Annual Meeting, April 17-18

This year the Bomb Committee, Bomb and Artillery Ammunition Division, held its annual meeting at the Air Force Armament Center, Air Research and Development Command, Eglin Air Force Base, Fla., on April 17-18, 1956.

N. L. Etten, Chamberlain Corporation, chairman, presided, and Brig. Gen. M. H. Davis, U. S. Army (Ret.), acted in his usual capacity of secretary and general manager.

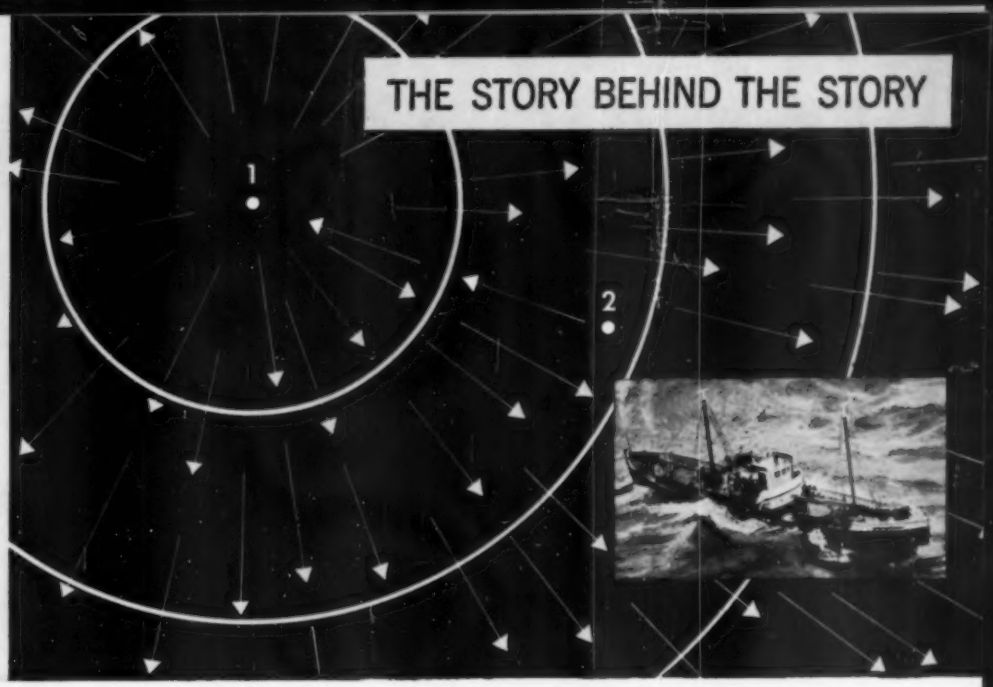
The Committee was welcomed to AFAC by Maj. Gen. Edward P. Mechling, commander. Col. Henry B. Kucheman, U.S. A.F., president of the Florida Post of the A.O.A., extended greetings from the Post.

The technical sessions included the following classified presentations:

"Development of the T53 Parafrag

THE PRINCIPLE OF ALL RADAR is illustrated at right. Radio waves, indicated by arrows, bombard any objects in their path and bounce back, presenting the object on the scope and indicating its range and bearing. With his Sperry Marine Radar, for example, the master of a ship (1) sees on the scope above the image of a ship in distress 9 miles away (2) and in total darkness.

THE STORY BEHIND THE STORY



FLYING IS SAFER, and navigation is simplified for Air Force planes equipped with Sperry APN-59 Radar. For example, thunderheads and other weather disturbances are revealed in advance, so course may be altered to avoid storms.

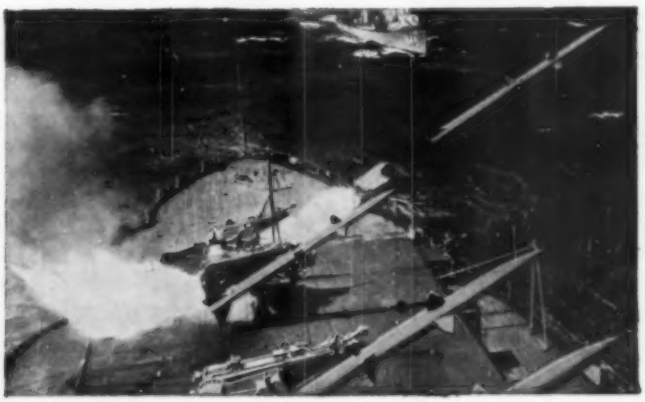
RADAR: DETERRENT TO WAR, PROTECTOR OF LIVES

Its uses Expand as its Ability to Detect the Unseen Increases

In a few short years, radar has passed from the experimental stage into a highly dependable servant of humanity. It helps to keep the peace—because its use in early warning networks reduces the possibility of successful enemy attack, while its use in new bombing and missile systems increases the probability of deadly retaliation. By pushing darkness and storms aside, it increases safety in transportation, protects property and saves lives.

To provide a thoroughly stable source of power for radar, Sperry developed the Klystron Tube. From this, Sperry has gone on to pioneer in every phase of radar development, working with every branch of the military, and with industry as well.

GUNFIRE CONTROL SYSTEMS owe much of their precision to radar. For example, an important one, this Mortar Locator developed by Sperry for the Army, uses radar to track an enemy shell, then plots its point of origin to locate an enemy battery.



MISSILES FOLLOW COURSES established by radar whether launched from air, land or shipboard, as in the case of these Navy Terriers, radar-guided by Sperry.

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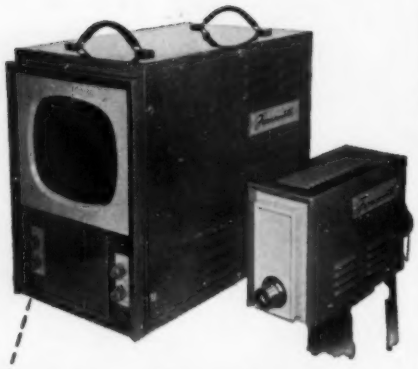

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Division Activities

Bomb and the T48 Antiricochet Devices," by Dr. Harold V. Hawkins and Chester Bilinski, Cook Research Laboratories.

"Development of the T58E3 Leaflet Bomb," by Dr. George Wolf and Ray LaPore, General Tire & Rubber Company.

"The 5,000-pound Bomb, T70," by Col. S. R. Stribling and W. M. Hawkins, ACF Industries, Inc.

"The Bomarc Warhead," by Fred Saxe, Picatinny Arsenal.

"Electric Fuzes for the New Series of Bombs," by Maurice Apstein, Diamond Ordnance Fuze Laboratories.

"Progress on the T36 Cluster and the T69 Bomb," by Irving Herman and Robert C. Smith, Chamberlain Corporation.

"Nike B Warhead" by G. C. Throner, Aerojet-General Corporation.

Under the general topic of "Air Force Armament, Bombs, and Related Equipment Development," the following subjects were discussed:

1. A general analysis of the Air Force bomb programs by Maj. R. W. Motis, Air Munitions Development Laboratory, AFAC.

2. Status of the Antitank Bombs (HEP and HEAT), by Maj. R. W. Motis, AFAC, and G. Keller, Globe American Corporation.

3. Comparative testing of Air Force and Navy bombs, by Capt. N. R. Eny, Directorate of Munitions Testing, AFAC.

4. Progress on bluff shape bombs, by Capt. C. C. Cox, Air Munitions Development Laboratory, AFAC.

5. Status Report of T28 and T37 frag bomb clusters, by Mr. Keller, Globe American Corporation.

6. The Doan Brook terminal ballistic effects of a special application of N.S. bomb (film), by Capt. John L. Camara, Air Munitions Development Laboratory, AFAC.

The second day of the meeting was given to AFAC activities. In the morning Capt. Marvin B. Sullivan, Directorate of Technical Support, covered AFAC test facilities and ranges. Maj. Relf A. Fenley, Directorate of Munitions Testing, covered munitions testing at AFAC.

Maj. John F. Phelps, Directorate of Munitions Testing, conducted firing demonstrations at Range 22 for the Committee. This was followed by a tour of the Heavy Systems Building under the direction of Col. Henry B. Kucheman, Maj. George P. Brenner, Maj. James W. Hayroth, and Captain Sullivan—all of the Directorate of Technical Support.

Lieut. Col. Jack W. Whitsett, Operations Division, conducted the Committee on a tour of inspection of AFAC aircraft.

In the afternoon the Committee met in executive session to conduct Committee

Hunting—and the Fighter Who Rode Black Nell

It took death to stop Bill Hickok's search for adventure. This legendary figure scouted for the Army in Indian campaigns . . . spied far behind Confederate lines . . . and, as marshal, brought law where there was no law. Only natural such a man should turn to hunting and enjoy it to the hilt.

Wild Bill's enthusiasm for the hunt can be seen in a youth's letter to his mother: ". . . I quit writing to go hunting. Now I thought I would write and tell what luck I had. One young buck and two turkeys, which I carried home on my back." And this enthusiasm grew with his marksmanship. Though Buffalo Bill was a close friend, Hickok's pride in his own skill led him to say: "Cody kills Buffalo with a rifle. I can kill 6 buffalo with my pistol while he is killing one." Wild Bill's gun was his creed—and he lived by it.

Since pre-Revolutionary days, Americans have found in hunting the thrilling action and keen enjoyment they look for in a pastime. It's a sport that challenges wits, reflexes, stamina and skill. Equally important, hunting serves to build self-reliance and endurance . . . a valuable contribution to our nation's well-being.

Today, the great American tradition of hunting can be perpetuated only by thoughtful preservation of wildlife. Throughout the country hunting associations are cooperating with public agencies to promote proper conservation. Do your part in preserving this heritage—join or support one of these groups now. E. I. du Pont de Nemours & Co. (Inc.), Explosives Dept., Wilmington 98, Delaware.

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business and formulate the Committee report. This completed another very successful meeting of this very active Technical Committee.

In the evening the Committee joined with the Florida Post, A.O.A., in an enjoyable dinner session at the Eglin Air Force Base Officers' Open Mess.

Proving Ground Instrumentation Group Meets at Naval Ordnance Test Station

The Proving Ground Instrumentation Committee of the Fire Control Instrument Division met at the Naval Ordnance Test Station (NOTS), China Lake, Calif., on April 18-20, 1956. Hugh C. Carroll, General Electric Company, chairman of the Committee, presided at the sessions which were attended by about twenty Committee members and a representative group from NOTS.

Capt. F. L. Ashworth, U.S.N., Commander of the test station, welcomed the Committee and gave a very comprehensive description of the station's scope, function, and facilities. Dr. W. B. McLean, technical director, NOTS, described the activities of the station, illustrated with charts showing the statistical breakdown of each activity.

A. S. Gould, chairman of the China Lake Chapter, Los Angeles Post, A.O.A., welcomed the Committee on behalf of the local A.O.A. organization, and announced that a social hour and informal dinner would be held the following evening at the Officers' Club. About eighty persons attended this pleasant affair.

After luncheon the Committee was taken on a tour of several ranges and facilities of the station. It was impressed on the group that NOTS was not a proving ground in the usual sense but was rather a development testing center.

The supersonic Naval Ordnance research track (SNORT) was visited. This facility is unique and the only one of its kind in the country. The "C" (aircraft), and "G" (free-flight test ranges), the China Lake pilot plant, and the static firing facilities also were visited and examined.

The second day was devoted almost entirely to a general Committee meeting conducted by Chairman Carroll. The general scope of problems confronting the Committee was discussed. Brig. Gen. T. K. Vincent, A.O.A. Staff Consultant for Technical Divisions and Committees, described the Association's technical activities and read the pertinent sections of the policies and procedures which are required to be read at all technical Division and Committee meetings.

Dr. I. E. Highberg, chief, Testing Department, NOTS, gave a very graphic description of the problems confronting his department in obtaining instrumentation and facilities for development testing, mainly due to administrative and fiscal procedures.

The Committee was then divided into four panels, each covering a phase of the proving ground instrumentation problem. These panels were Armament Testing and Instrumentation Needs, Dr. N. C. Peterson, the Rand Corporation, chairman; Data Reduction and Processing, Henry C. Maulshagen, Air Force Armament Center, Eglin Air Force Base, chairman; Position Determination in Space, W. H. C. Higgins, Bell Telephone Laboratories, Inc., chairman; and Computation, A. E. Cooper, International Business Machines, chairman.

The panels met with representatives from NOTS to discuss their problems in these areas. The panels held three sessions each, at which there were classified discussions.

The courtesies extended by Captain Ashworth were outstanding, and the excellent arrangements made by him and his staff made this visit a most delightful and instructive occasion.

Classified Meeting Held by Small Arms and Small Arms Ammunition Division at Springfield Armory

The Small Arms and Small Arms Ammunition Division held its annual meeting on May 3rd at the Springfield Armory. This was a classified meeting and about 150 members and consultants of the various Committees of the Division were present. Frederick F. Hickey, Savage Arms Corporation, chairman of the Division, presided. Col. W. J. Crowe, Savage Arms Corporation, Division secretary, continued the fine work which Col. Wallace L. Clay had done for so many years before he retired as Division secretary.

Col. D. G. Ludlam, Springfield Armory commander, welcomed the group on behalf of the Ordnance Corps. This year's meeting was held in the vast area which comprises the first floor of Main Arsenal, one of the historic buildings at the armory. One end of the hall was devoted to an exhibit of current research and development weapons.

Maj. A. J. Millard, Inf., from CON-

Here's why! Navy's largest circuit breaker is housed in new all-aluminum switchboard

From the time electricity was installed in Navy ships, the switchboards that control the power generally have been made from steel and copper. But progressive marine engineers have long been aware of the weight-saving properties of aluminum, and the idea of aluminum switchboards intrigued them.

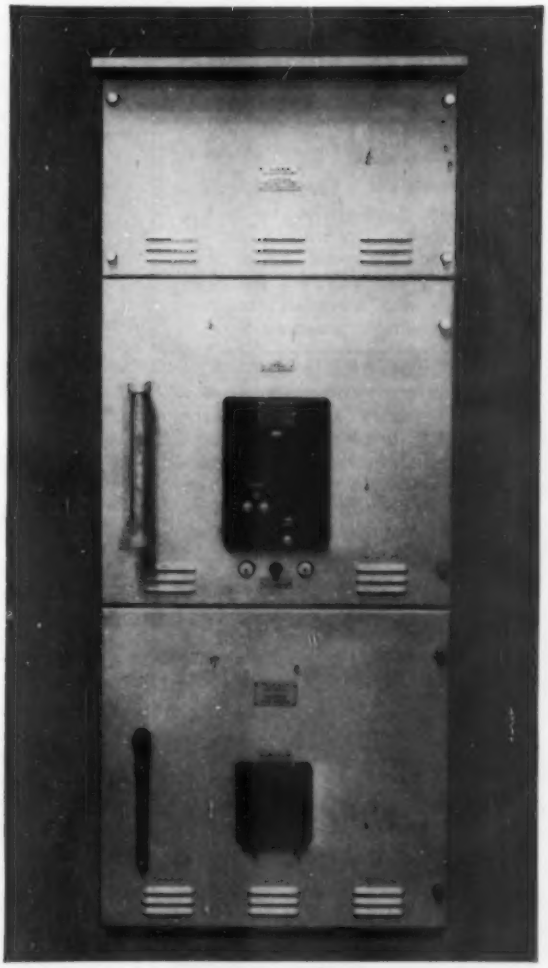
In the early 1950's the Bureau attacked the problem in earnest. After a careful study of the numerous technical problems a "guinea-pig" switchboard was built using aluminum for framework and bus work. This switchboard, the type used on CVA-59 class carriers, incorporated the Navy's largest circuit breaker (3,200-amp, high interrupting capacity). If aluminum proved feasible here, any similar type of unit would also be practical.

The new aluminum switchboard was given high-impact shock tests. *It resisted vibration far better than steel units.* Electrically the board was entirely adequate, successfully completing 100,000-ampere short time tests.

Most important, this type of board showed a weight saving over steel of about 35%—amounting to *over 60 tons* on a CVA-59 class carrier. Cost-wise, the aluminum switchboard about matched steel but the cost of future aluminum boards is expected to decline.

Grand result: Alcoa predicts an extremely bright future for aluminum switchgear, both for marine and industrial use.

Can aluminum make your products better, cheaper or lighter? Let Alcoa help you find out. We have unparalleled facilities to help you "imagineer" in aluminum. ALUMINUM COMPANY OF AMERICA, 850-G Alcoa Building, Pittsburgh 19, Pa.



Newport News Shipbuilding Photo by Nixon

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The design and manufacture of precision gages is a highly specialized operation . . . not a "tag-a-long" project.

Do you employ within your organization personnel especially trained for this craft?

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Vulcan is not a new name in the precision gage field. For many years, their highly trained and experienced personnel have been designing and selecting the right methods and materials for hundreds of custom precision gages.

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You know today's markets are competitive. Don't practice false economy in your organization by permitting your precision gage requirements to became a "tag-a-long" operation.

Bring them to VULCAN. You will be pleased with the prompt, expert attention you will receive. VULCAN can help you operate at peak efficiency.

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ARC, Board No. 3, Fort Benning, Ga., gave a most interesting and complete talk on the "Relationship of User to Ordnance in Small-Arms Development."

Lieut. Col. J. Laitos, Air Force Armament Center, Eglin Air Force Base, Fla., discussed the "Air Force Armament Center Rôle in Development of Aircraft Small Arms." He covered the increasing part of the Air Force in the armament field, and paid tribute to the benefits derived from A.O.A. Technical Committee assistance.

At this point the host service, the Army Ordnance Corps, presented a number of experts to discuss interesting phases of their work. Lieut. Col. R. E. Rayle, Springfield Armory, discussed "Research and Development Contracts for Small-Arms Development," followed by Maj. E. M. Dooley, Springfield Armory, who discussed "Phasing of Small Arms from Development into Production."

S. W. Fish, Springfield Armory, brought the Division up to date on the "Status of the Light Rifle Program." E. M. Harvey, Springfield Armory, discussed "General-Purpose Machine Gun Development," and H. F. Hawthorne, Springfield Armory, described the developments of the "Tank Machine Gun." E. Read, Frankford Arsenal, covered the advances in "Small Arms Ammunition."

In the field of aircraft armament, J. R. Ewes, Springfield Armory, spoke on the "Revolver Aircraft Weapons"; H. C. Handy, Springfield Armory, discussed "Multibarrel Aircraft Weapons"; and O. H. von Lossnitzer, Springfield Armory, presented forecasts on "Future Aircraft Weapons."

Robert Ledoux, chief of the Photographic Laboratory, Springfield Armory, showed a film made up of selected high-speed movies of small-arms weapons under test.

After luncheon in the armory cafeteria, the group returned to Main Arsenal for a demonstration display of weapons. Then the members proceeded by buses to the firing ranges on Page Boulevard for weapon-firing demonstrations under the supervision of Capt. R. W. Schreck.

In the evening the Division members joined with the Hartford-Springfield Post, A.O.A., for an excellent dinner meeting at the Hotel Sheraton-Kimball. Maj. Gen. E. P. Mechling, commander, Air Force Armament Center, Eglin Air Force Base, made the principal address, covering the need for research and development emphasis if we are to maintain our world defense position.

Chairman Hickey announced that the next meeting would be held at the Air Force Armament Center, probably in February 1957, at the invitation of General Mechling.

Metal Working Lubricants Committee Meets at Naval Ordnance Plant, Ky.

The Metal Working Lubricants Committee, Advisory, Technical and Research Group, held its ninth meeting at the U. S. Naval Ordnance Plant, Louisville, Ky., on May 8th.

Wilbur J. Reitze, Esso Standard Oil Company, chairman of the Committee, and George W. Gleim, Esso Standard Oil Company, secretary of the Committee, arranged the details of the meeting and the interesting program.

Chairman Reitze opened the first session and announced that the Committee was four years old and had held regular semiannual meetings since its formation.

Capt. Herman N. Larson, U.S.N., commander of the Naval Ordnance Plant, Louisville, Ky., welcomed the Committee and gave a very interesting talk, illustrated by charts and maps, describing the scope of activities of NOP.

S. R. Fogarty, master mechanic at NOP, described the equipment and capabilities of the shops and facilities there.

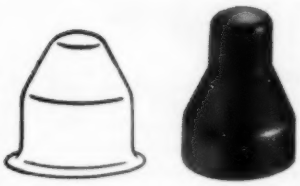
Chairman Reitze emphasized the purpose of the meeting and the desirability for more service-industry problems in the metal-working lubricants field.

Brig. Gen. T. K. Vincent, staff consultant for A.O.A. Technical Divisions and Committees, discussed future plans for the technical organizations of A.O.A. and paid tribute to the fine work of this Committee and to its officers and members.

Louis H. Sudholz, Socony Mobil Laboratories, gave a very interesting illustrated talk on "Mobil Tapping Tests," which had been conducted by his organization in an attempt to evaluate various cutting media quickly. This paper evoked a lively discussion and was an excellent contribution to the art.

Marco Petronio, Frankford Arsenal, led the discussion of "Arsenals' Soluble Oil Specifications" in which the entire Committee joined. The coöperation of the Interarsenal Committee in preparing the draft of the specifications was recognized and applauded.

After lunch, the Committee was conducted on a tour of the Naval Ordnance Plant and the Clayton & Lambert Company's operation of the JAN Steel Cartridge Case Plant, located within the Naval Ordnance Plant. (*Cont. p. 90*)



PREFORM	FINAL FORM
1 1/16" dia. 1 3/4" high	1 1/16" dia. 2 1/4" high

2 OPERATIONS plus anneal—.032" AMS 5521. Jet engine part formed by redrawing a cup.

PREFORM	FINAL FORM	PREVIOUS METHOD
3 1/4" dia. 3 1/4" high	2 1/8" dia. 5 1/8" high	

2 OPERATIONS—.043" AMS 5540. Jet engine part formed by redrawing a cup. Part at right shows previous forming method of welding two stamped sections together.

PREFORM	FINAL FORM
1 1/2" dia. 1 3/4" high	1 3/4" dia. 2 3/8" high

2 OPERATIONS—.020" Hy Mu 80. Part formed by redrawing a cup.

Hydroforming

takes less time, less dollars to form tough shapes, tough metals

PREFORM	FINAL FORM
1 3/4" dia. 1 1/4" high	1 3/8" long 1/2" wide 1 1/2" deep

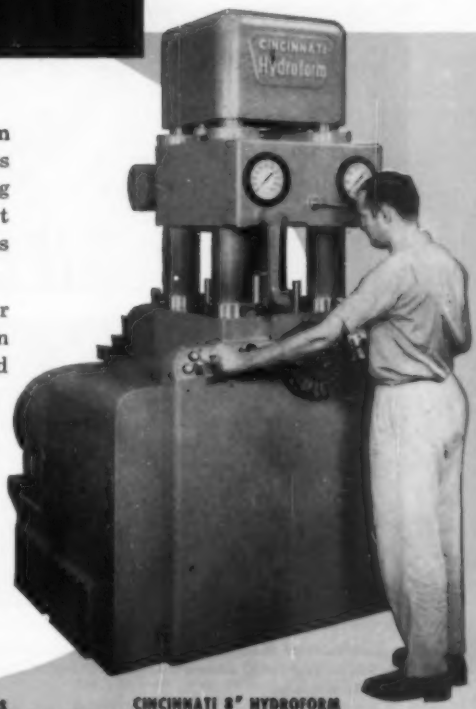
2 OPERATIONS plus anneal—.025" Brass. Instrument cover formed by drawing a cup into the final rectangular shape.

■ Shown here are several parts drawn on Cincinnati Hydroform machines. These range from tough shapes of ductile materials to less complex shapes of harder-to-work alloys. In each instance, Hydroforming substantially reduced the number of operations required to form the part conventionally . . . used simple tooling, costing from 25% to 90% less than conventional tools . . . and produced a part of higher quality.

These advantages—better parts, in fewer operations, at lower costs—can be yours by Hydroforming. Let a Process Machinery Division field engineer give you full details. For a description of the process and specifications of the six machine sizes, write for Bulletin M-1908.

1 OPERATION—.030" Brass. Automotive detail.

1 OPERATION—.034" CRS, deep-drawing quality. Previous forming method required drawing the can, cutting a slot in the wall and welding on the protruding section.



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Bendix

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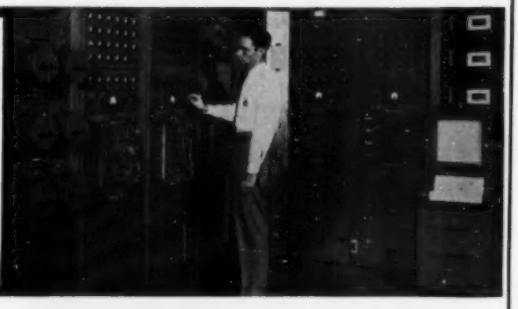
offer interesting jobs with outstanding futures

SYSTEMS ANALYSIS

Engineers are needed to work on fundamental problems of analytical dynamics in missiles and weapons systems. Ability, training, and experience in analogue and digital computers, breadboards, prototype of missile equipment, and electronic and mechanical simulators are essential in these positions.



ELECTRONIC GUIDANCE

Electronic Engineers with backgrounds in microwave, radar and servo systems are needed to design and develop guidance systems for a major guided missile project.

Mechanical Engineers are needed to design and develop electronic packaging for complex missile guidance systems.

MISSILE SYSTEMS TEST

The whole is the sum of its parts. In our missile program, the high-caliber testing of the parts has an effect on the over-all missile performance. We want engineers with a good background in fundamentals who have experience in this systems type of testing.

Bendix Guided Missiles offer interesting job opportunities to Senior Engineers, Assistant Engineers, Junior Engineers and Technicians.

A thirty-six page book, "Your Future in Guided Missiles", describing in detail the many phases of our guided missile operation and the job opportunities available to you, will be sent to you on request. Write for your copy today. BENDIX PRODUCTS DIVISION—MISSILES, 405D, Bendix Drive, South Bend, Indiana.

Division Activities

This tour was most impressive. The completeness of the equipment, the complexity and variety of work being done, and the quality of the workmanship were outstanding. The comments of the group were most laudatory, in particular regarding the superior "housekeeping."

The Committee was very appreciative of the courtesies extended it by Captain Larson; Commander Ham, executive officer at NOP; and the staff and personnel during the visit. The arrangements were perfect and the interest displayed by the plant personnel in the Committee's work was most gratifying. This plant is a valuable asset to our national defense, and the Committee is most appreciative of the opportunity to visit it.

Instrument Jewel Bearing Unit, Fire Control Instrument Division, Holds Meeting at Washington, D. C.

The Instrument Jewel Bearing Committee of the Fire Control Instrument Division convened in Washington at the Engineers Club, Wednesday, May 16, 1956.

Presiding officer at the meeting was William M. Brandes, vice-president, Elgin National Watch Company, chairman of the Committee, who welcomed a large turnout of the Committee, its consultants, and guests who represented a cross section of the jewel bearing industry and the three services.

The members and guests were welcomed to the meeting on behalf of the national officers and directors of the Association by Capt. J. M. P. Wright, U.S.N. (Ret.), staff consultant for A.O.A. Posts and Chapters. He stressed the importance of the Technical Divisions and Committees of the Association and the contributions they were making toward solid industry-Ordnance relationships. He read portions of the preamble of the A.O.A. constitution and general operating policies and procedures pertaining to proscribed activities.

The following interesting presentations were made by: Robert W. Danielson, Bulova Watch Company, "Report on Jewel Bearing Activities at Rolla, N. Dak."; W. M. Brandes, Elgin National Watch Company, "Report on Jewel Bearing Activities at Elgin, Ill."; Maj. C. G. Hershey, Jr., Frankford Arsenal, "Report on Service Viewpoint of Bulova and Elgin Installations."

After a full morning session the meeting adjourned to the dining room of the Raleigh Hotel for an informal luncheon.

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Today, it takes more than a better mousetrap for the world to beat a well worn path leading to your door.

Today, it takes the helping hands of diversified industries united under one progressive management.

. . . A management that has the background to cut costs and step-up production, and at the same time insure quality leadership for each and every product.

. . . A management that utilizes the help of each division—in getting the best from all divisions.

. . . A management with an attitude that fosters new markets and improved products.

USI is such an organization—a dynamic group of divisions serving many industries where its products are accepted as the finest in the field. An organization that is noted for its ability to give a helping hand to any branch of industry.

CLEARING MACHINE CORPORATION. Mechanical and hydraulic metal-forming presses and accessories. Plants at Chicago, Illinois, and Hamilton, Ohio.

CHICAGO STEEL TANK COMPANY. Steel tanks of all sizes for industry. Plant at Chicago, Illinois.

AXELSON MANUFACTURING COMPANY. Petroleum pumping equipment, milling machines, engine lathes, aircraft components. Plants at Los Angeles and Montebello, California, and St. Louis, Missouri.

CONDUIT FITTINGS CORPORATION. Small electrical parts and die-castings. Plant at Chicago, Illinois.

SOLAR PERMANENT COMPANY—Refrigerated bulk milk tanks and cookware. Plant at Tomahawk, Wisconsin.

ORDNANCE DIVISION. Modification and processing of armored vehicles of all types. Plant at Hegewisch, Illinois. Also operates ordnance shell plant at Rockford, Illinois.

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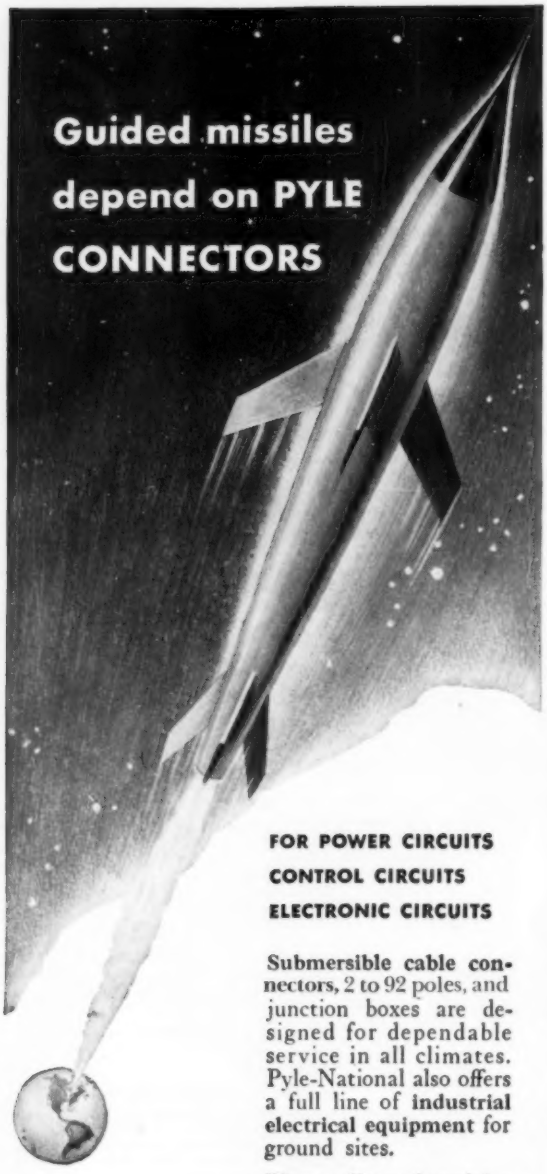

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CONTROL CIRCUITS
ELECTRONIC CIRCUITS

Submersible cable connectors, 2 to 92 poles, and junction boxes are designed for dependable service in all climates. Pyle-National also offers a full line of **industrial electrical equipment** for ground sites.

Please direct inquiries to: Manager of Special Products.

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Where Quality is Traditional
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NEW DEVELOPMENTS

NEW NAVY MISSILES

Fleet and shore-based Navy aircraft are now being armed with the supersonic air-to-air guided missile Sparrow I. The missile can be launched from jet fighters against high-speed aircraft and other missiles.

Sparrow I's velocity is greater than 1,500 miles an hour within seconds after launching. It is powered by a solid-propellant rocket motor, is approximately 12 feet long and weighs about 300 pounds.

The Navy missile may be launched either singly or in rapid sequence. Guidance signals deflect the missile's wings and direct it to intercept the target even under evasive action.

The Petrel, a new air-to-surface guided missile, is also now

Petrel missiles under wings of P2V patrol airplane.

in operation with the fleet. Described as one of the Navy's more complex missiles, "both electronically and dynamically," the Petrel is designed primarily for use against enemy ships and can be launched by airplanes beyond the range of a target's air-defense system.

An intricate electronic brain is essential to the Petrel since the missile itself must "think" its evasive way to the target.

The missile was developed under the technical direction of the Navy's Bureau of Ordnance by the National Bureau of Standards. It is produced by the Fairchild Engine and Aircraft Corporation.

Other Navy missiles are the Regulus, a surface-to-surface type, and the Terrier, a surface-to-air missile which can be launched from submarines.

NEW AIRBORNE DIVISION

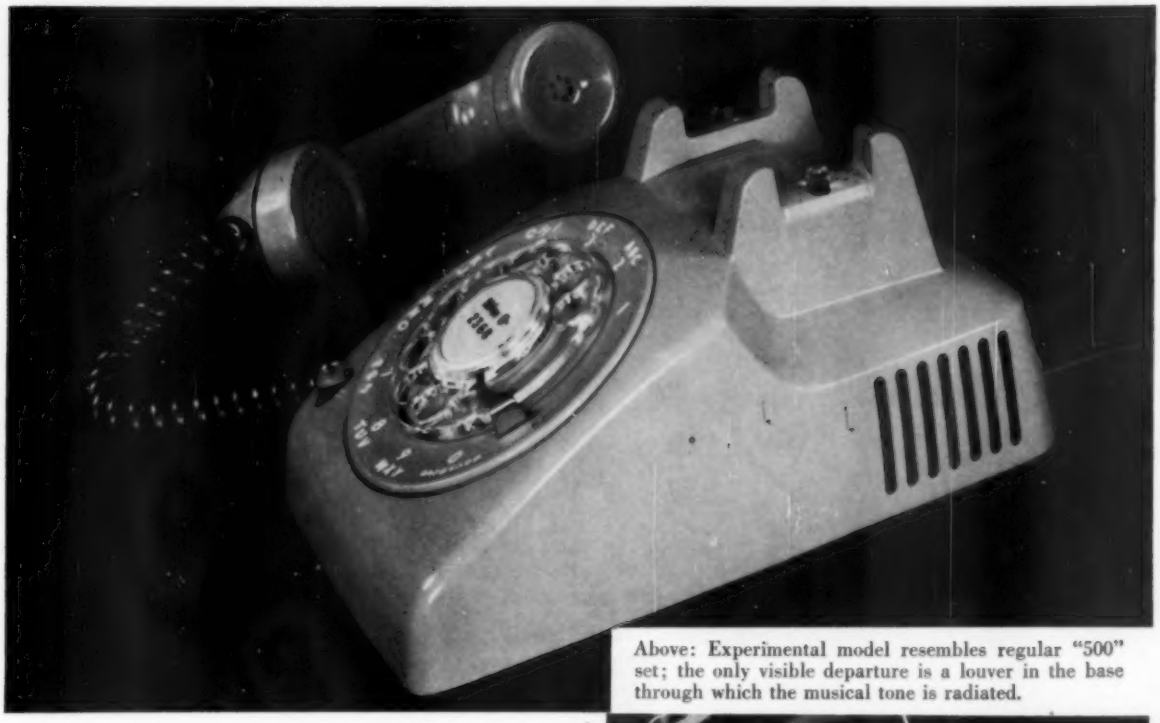
Activation of the 101st Airborne Division this fall at Fort Campbell, Ky., will begin moving the atomic-age Army off the planning boards and into the field. Defense Department officials have announced that the 101st will "be organized for battle in an atomic war."

Breaking from the traditional regimental-type organization, the division will have a total strength of 11,500 with 5 combat groups—each a self-contained force capable of fighting independently.

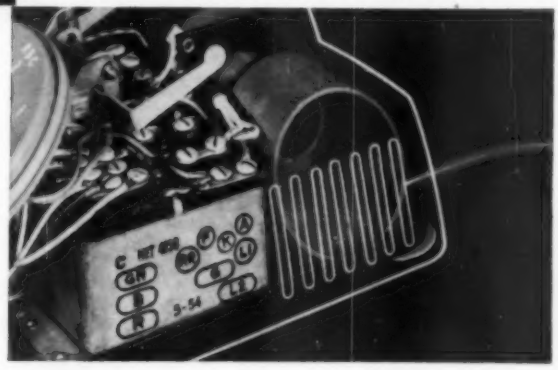
The newest weapons are scheduled for this new unit, including the SPAT—a self-propelled 90-mm. gun which can be dropped by parachute—105-mm. mortars, and lightweight general-purpose machine guns. An atomic punch will be provided by Honest John rocket units in the division's artillery.

Atomic-age ground mobility will be provided by a family of new lightweight trucks, including the Mechanical Mule—a 4-wheel-steering, 1000-pound-capacity, low-silhouette vehicle.

Transistorized telephone summons you with a musical tone



Above: Experimental model resembles regular "500" set; the only visible departure is a louver in the base through which the musical tone is radiated.



Bell scientists have developed a new musical tone device which may some day replace the telephone bell, if it meets technical standards and customers' approvals.

Because the musical tone equipment uses transistors, the tones will be transmitted with the same amount of power required to transmit a telephone conversation — considerably less than is needed to make a telephone bell ring.

The experimental telephone sets resemble the current "500" sets; the only external difference is a louver at the side of the base through which the tone is radiated by a small loudspeaker mounted inside the telephone's base.

Tests have shown that the musical tone can be heard at great distances. It stands out above general room noise and can be distinguished from such sounds as ringing of doorbells, alarm clocks, and home fire alarms.

This new low-power signaling technique is expected to play an important part in the electronic switching system now under development at Bell Laboratories.

Above: Bell ringer has been displaced by a small loudspeaker in transistorized telephone. Left: L. A. Meacham heads the team of engineers that developed the musical tone ringer. Mr. Meacham holds a B.S. in Electrical Engineering from the University of Washington, Class of '29. He became affiliated with Bell Labs a year after his graduation. In 1939 Mr. Meacham won the "Outstanding Young Electrical Engineer" award of Eta Kappa Nu.

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WINCHES

Put an advanced Gar Wood 7000 lb. winch on your utility truck and you'll put an end to clutch trouble. All moving clutch parts are *fully enclosed and running in oil* . . . can't stick, freeze or rust because weather and dirt can't get in!

You'll put an end to the hazard of sudden slippage, too. Gar Wood's self-energizing safety brake and time-tested back-draft clutch give your operator much safer control of the load.

And that's not all! Gar Wood winches feature stress-free, tempered aluminum alloy housings that are light-weight, rustproof, built for longer life . . . built-in rope clamp for easier attaching and changing of rope, better spooling . . . self-contained ball-bearing mounted worm shaft for smoother operation . . . extra rugged base angles for an extra margin of safety.

Get all the facts about Gar Wood 7000 lb. winches, available as standard or low mount. Call your Gar Wood-St. Paul distributor, or write to Customer Service Department, Gar Wood Industries, Inc., Wayne, Mich.

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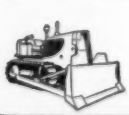
Gar Wood-Buckeye Ditchers


Gar Wood Tractor Equipment

Gar Wood-St. Paul Hoists & Bodies

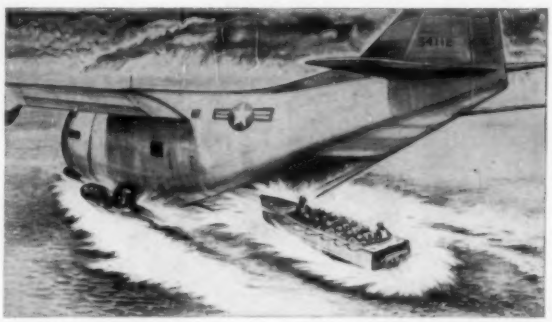
New Developments (Contd.)

Better air mobility will be possible since the 101st will have 6,000 fewer personnel than the conventional airborne division and can be air transported with half the aircraft previously used.

An airborne television system will keep the division commander supplied with the latest front-line information.

FAST TROOP LANDING

A revolutionary new method of launching assault boats at beachheads from airplanes has been developed by All American Engineering Company, Wilmington, Del. A cargo pod or landing barge is attached to the underside of, or placed inside, an aircraft equipped with the company's "universal landing gear"—hydro-lift skis that allow the aircraft to land on water and keep it on the surface as long as forward speed is maintained.



Troop-filled barge leaves aircraft while in motion.

As the airplane maintains forward taxi speed the barge, which has its own motive power, is detached from the aircraft or is released from inside. As soon as the barge is released, it proceeds to the beach, and the aircraft takes off and returns to the loading point to pick up another. The entire landing operation is performed without stopping the forward speed of the aircraft.

COCKPIT CAPSULE

The Navy has developed a standard cockpit "capsule" which will provide greater pilot safety and substantial saving in the recovery of valuable instruments from jettisoned jet aircraft. Produced by Douglas Aircraft Company for the Office of Naval Research, the ejectable capsule—a recoverable escape device for pilot and the airplane's electronic equipment—will be interchangeable with other aircraft.

Jettisoning can be either manual or automatic. Stabilizing fins extend and a drag chute opens as the unit is ejected. The first chute activates the main parachute. The capsule is built to absorb the shock of landing and will float for an extended period of time to afford the pilot all-weather and survivor protection.

RAIN REPELLENT

A rain repellent for airplanes has been developed by Navy Bureau of Aëronautics chemists to eliminate the need for mechanical windshield wipers, which are impractical in high-speed jet aircraft. The repellent, made up essentially of silicones and waxes, sets up a hard coating on the glass, making water behave more like beads of mercury. Rain then is swept off in droplet form by the wind.

NUCLEAR WARHEADS

The Air Force has revealed that a major scientific "breakthrough" in developing small nuclear warheads has simplified the development of long-range ballistic missiles. The disclosure was made by Maj. Gen. Samuel R. Brentall, Air Force Assistant Chief of Staff for Guided Missiles, in testimony made public by the House Appropriations Subcommittee on Air Power.

Until now, General Brentall said, "warhead size imposed

Guide words for today —

"Must I shoot a simple-minded soldier boy who deserts, while I must not touch a hair of a wily agitator who induces him to desert?"

ABRAHAM LINCOLN

Lincoln's timeless truths were phrased in a style so simple that their meaning was unmistakable. In the above statement Lincoln makes it clear that he believed in fixing responsibility upon the prime movers . . . those who motivate others to commit overt acts against our country. What would Lincoln think of today's "liberals", who are not Communists themselves, but who condone Communist subversion and treason under the guise of "civil liberties"? There can be no doubt that he would crash his contempt upon such men.

W B Stuart

PRESIDENT

DUTY HONOR COUNTRY — LABOR BUSINESS GOVERNMENT

The **GRAY** Manufacturing Company, Hartford 1, Conn.

Audograph, PhonAudograph and Telephone Dictation Systems

and Gray Research & Development Co., Inc., Specialists in Video, Audio and Electro-mechanical Devices

Just a squeeze sets the fastening stud in steel or concrete!

THAT'S HOW SIMPLE IT IS—a flex of the finger—to anchor fixtures securely with the Remington Stud Driver. Off goes the power load, the stud is anchored into steel or concrete—straight as an arrow. No predrilling or outside power source required!

You can set both ¼" and ⅜" diameter studs with the Remington Stud Driver—up to 6 studs per minute either size. **There are 40** different styles and lengths of Remington Studs to choose from. With this *one* tool, you can take on *every* stud-fastening job—light, medium and heavy-duty—and save time and money on every one of them! Get full details by mailing coupon below.

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Please send me your free booklet which shows how I can speed my job and save with the Remington Stud Driver.

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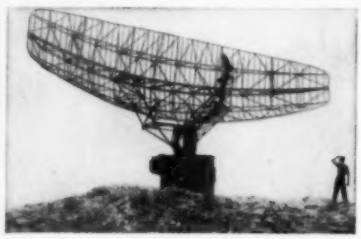
New Developments (Contd.)

severe requirements in areas of guidance, propulsion and reëntry . . . This breakthrough changed the nature of scientific war by simplifying the development of a usable long-range ballistic missile."

He pointed out that "the advent of lightweight high-yield warheads made ballistic missiles attractive because it simplified . . . many technical problems and ensured that thermonuclear explosives would be light and handy enough to be carried by long-range missiles of reasonable size."

NEW RADAR NETWORK

A contract to develop and manufacture radar installations for fifteen major airports stretching across the width of Canada has been awarded by the Canadian Government to Raytheon Manufacturing Company. The radar network will be a major factor in the Canadian



The 40-foot surveillance antenna.

Department of Transport's comprehensive program of transcontinental airport development and air traffic control, specifically aimed at equipping Canada's airways for the jet age.

The equipment, designated airport and airways surveillance radar (AASR), will make it possible to keep aircraft flying between any of Canada's fifteen major airports under close observation, even in stormy weather. Because Canada's principal airports, with but one exception, are no more than 400 miles apart, the overlapping patterns of radar surveillance will provide almost continuous coast-to-coast coverage.

The ability of the AASR system to detect and track aircraft in rain and other bad weather—which frequently causes excessive visual interference on the radar viewing scope—is an important advantage of the equipment. This benefit is obtained through the flexibility of the system which permits the operator to select either linear or circular polarization of the radar signal, depending upon weather conditions.

Another feature of the system which contributes to its visual clarity is "moving target indication"—a built-in ability to select only moving objects by filtering out reflections from fixed objects, such as buildings, mountains, and other unde-

For want of a nail the shoe is lost,
for want of a shoe the horse is lost,
for want of a horse the rider is lost.

George Herbert's statement applies to electronics today as it did to riders three centuries ago. The point may be illustrated by considering a vital electronic unit made up of thousands of components. If the least of these components fails, the whole unit may fail—and with it a strategic military mission.

The problem of *reliability* is becoming increasingly important as the science of electronics advances. "Black boxes" are hard pressed to perform more complicated tasks with increasing efficiency. And at the same time, the requirements call for smaller dimensions. Notwithstanding environmental extremes of an order hitherto unknown, every resistor, capacitor and relay *must* perform *reliably.* Each "nail" is critical.

That is why RCA is continuing its vigorous search for ways and means to increase the reliability of every component in an electronic unit. This program never ceases. It follows through from design to field evaluation. Everything learned is immediately applied to current development and production.

In seeking a degree of electronic perfection never before attained, RCA joins hands with others in this field. This matter of *reliability* is an industry challenge to be met by ingenuity, brain power and engineering knowledge wherever it is found.

DEFENSE ELECTRONIC PRODUCTS
RADIO CORPORATION of AMERICA
CAMDEN, N.J.

Versatile, Fan Cooled

DC POWER SUPPLY

Now Available for Many Industrial Uses

● **Designed to Military Specifications**

This power supply is a component of the Air Force Ground Control Approach System. Output is 100 amperes in an adjustable range of 24 to 30 volts with variable input of 187-229 volts and 58-62 cycles. A magnetic reference control circuit maintains very close regulation under extreme conditions of temperature and input. The unit is processed to Military Specifications and features fan cooling for minimum size and weight. Components are de-rated for 50,000 hours' life.

● **Typical of Motoresearch Quality Equipment**

The above power supply is typical of Special Electrical Equipment designed and manufactured by Motoresearch Company. Other specialties include high frequency motors, motor generators, engine generators and shaded pole induction gearmotors.

● **Consult With Us**

When you need special electrical equipment, send us your specifications and schedule quantity requirements. We will appreciate the opportunity to offer a proposal for your consideration.

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Designers — Gearmotors and Special Electrical Equipment — Manufacturers

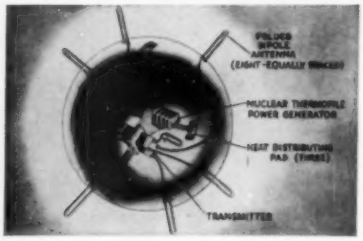
New Developments (Contd.)

sirable reflections, from the radar viewing screen.

"SPACE COMPASS"

Man-made satellites circling the earth every 105 minutes to serve as all-weather "space-compasses" for ships and aircraft were forecast recently by Lovell Lawrence, Jr., assistant chief engineer for product design, Chrysler Corporation Missile Operations, Detroit.

The Astro (artificial satellite time and radio orbit) could be fired into outer space from Alaska on a course which would take it over the North Pole. A



Nondirectional radiating satellite.

strong radio beam could be transmitted upward from the Pole to cut the Astro's power as soon as it comes over, letting it fall into its orbit 600 miles from the earth. Once in the orbit, it would travel at a speed of 276 miles a minute, Mr. Lawrence predicted.

Three Astro's would be fired into outer space 8 hours apart to provide a radio signal that could be plotted from any point of the earth in any weather every 105 minutes.

Power source for the Astro would be one pound of strontium 90 combined with an yterrium isotope providing enough power for twenty years, after which a new Astro would be fired into the orbit.

AIR TRAFFIC DEVICE

The Boston Electronics Division of American Machine & Foundry Company has developed, under contract to the Army Signal Corps, a special cathode ray tube display facility for presenting information pertaining to an aircraft traffic situation. Essentially, the equipment is the electronic equivalent of existing manually operated plotting boards which are becoming less effective as aircraft speeds increase.

The electronic display equipment is basically a plan position indicator for a trace-while-scan surveillance radar system. Each aircraft under surveillance is displayed as a coded symbol centered at the aircraft's plan position coördinates. The symbol consists of a dot marking the location of the aircraft; a velocity vector originating at the target dot to indicate the heading and approximate

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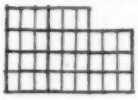
STACK BETTER  **STORE BETTER**

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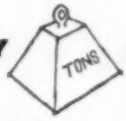
TOO BIG **...NOTHING TOO HEAVY** 

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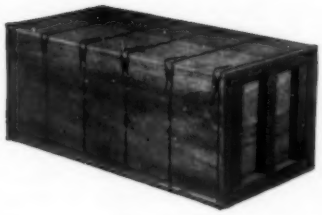

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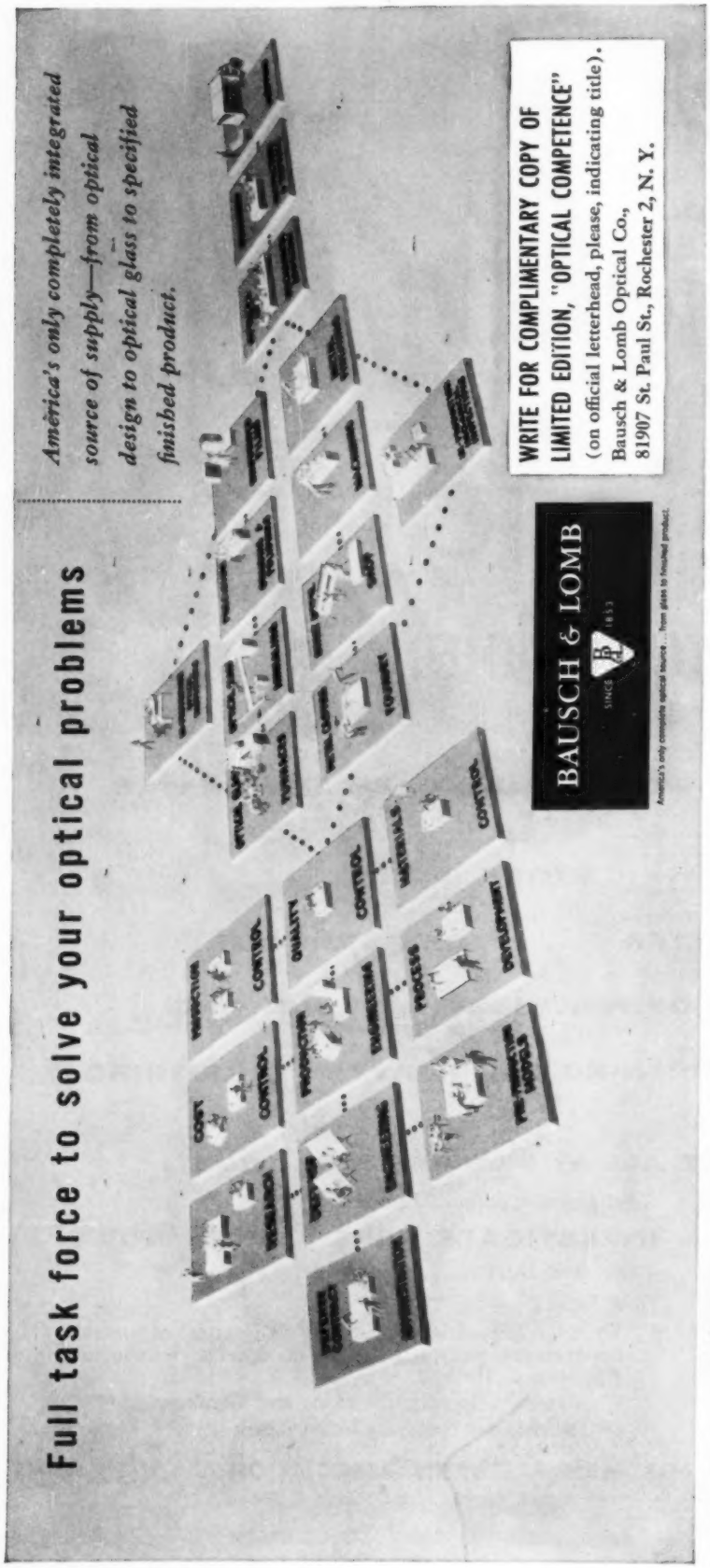
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New Developments (Contd.)

speed of the aircraft; a three-digit number for identification purposes; and an array of coded dots for presenting other pertinent data.

ARMY AVIATION

The Army will assume responsibility for the conduct of aviation training required in support of Army activities, the Department of Defense announced recently. The responsibility to be transferred to the Army will include aviation training in courses now conducted for the Army by the Air Force.

Assumption of training responsibility by the Army does not modify current rôles and missions of Army aviation nor authorize expansion of the Army aviation training program beyond the rôles and missions recommended by the Joint Chiefs of Staff and approved by the Secretary of Defense.

The Air Force will transfer Edward Gary Air Force Base and Wolters Air Force Base, Tex., to the Army in order to achieve maximum practical utilization of existing facilities and personnel.

Existing facilities at Gary Air Force Base will be used by the Army principally for primary fixed-wing pilot training by civilian contractors. Those at Wolters Air Force Base will be used by the Army chiefly for primary cargo helicopter pilot training by civilian contractors.

TEFLON IN BEARINGS

A development that many eliminate the need for conventional lubrication in many types of bearings was disclosed recently with the announcement of a new automobile suspension joint. Key to this development is the use of Teflon tetrafluoroethylene fiber woven into fabric. Teflon, one of the most slippery materials known, can now be used under heavy load, opening the door to development of improved bearings, many not requiring lubrication, it is claimed.

Use of Teflon fiber to face metal suspension joints, in addition to making it possible for them to function without customary lubrication, reduces the amount of friction by more than fifty per cent in comparison with standard lubricated suspension joints.

EXPLOSIVE BOMB RELEASE

A Navy aircraft, employing a small lightweight device developed by Modern Metal Crafts Company for the Navy Bureau of Aëronautics, has successfully released a bomb while flying at Mach 1.2 (approximately 840 miles an hour). This is the fastest speed for a bomb drop ever recorded in level flight. The device enables the bomb to take a routine trajectory, overcoming the tendency of the projectile to remain with the aircraft at such high speeds.

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MATERIALS PROGRESS

George S. Brady

Greater Zirconium Supply.—As has been pointed out previously in these columns, the hoped-for development of atomic power plants would be difficult, if not impossible, without larger supplies at lower costs of a number of scarce metals, of which zirconium is preëminent. A new expansion program, backed by the Atomic Energy Commission, aims at immediate plant developments that will not only increase greatly the supply of zirconium metal, but should result in reductions in price as much as forty per cent below present prices.

Largest of the several new producing facilities will be that of the *National Research Metals Corporation*, Cambridge, Mass. The new plant will be located near Pensacola, Fla., close to the plentiful supply of beach sand which is the basic ore, and adjacent to a subsidiary chemical plant which will furnish the nitric acid and ammonia for refining. A new sodium reduction process will be used. The plant has contracted to supply annually 700,000 pounds of hafnium-free zirconium but will have a larger capacity to furnish commercial grades of the metal to private industry.

It has been said that zirconium is as important to the nuclear reactor field as copper is to the electrical industry. The pure metal has a unique combination of high strength, great corrosion resistance, and resistance to neutron absorption which makes it invaluable as a construction material in reactors. It is still costly to separate the neutron-absorbing hafnium from the zirconium, and further research is needed along this line to reduce costs still further.

However, as a strong, corrosion-resistant metal for the chemical industry, zirconium need not be hafnium-free, and for the first time the new production expansions will make the metal available at an economical price for industrial application.

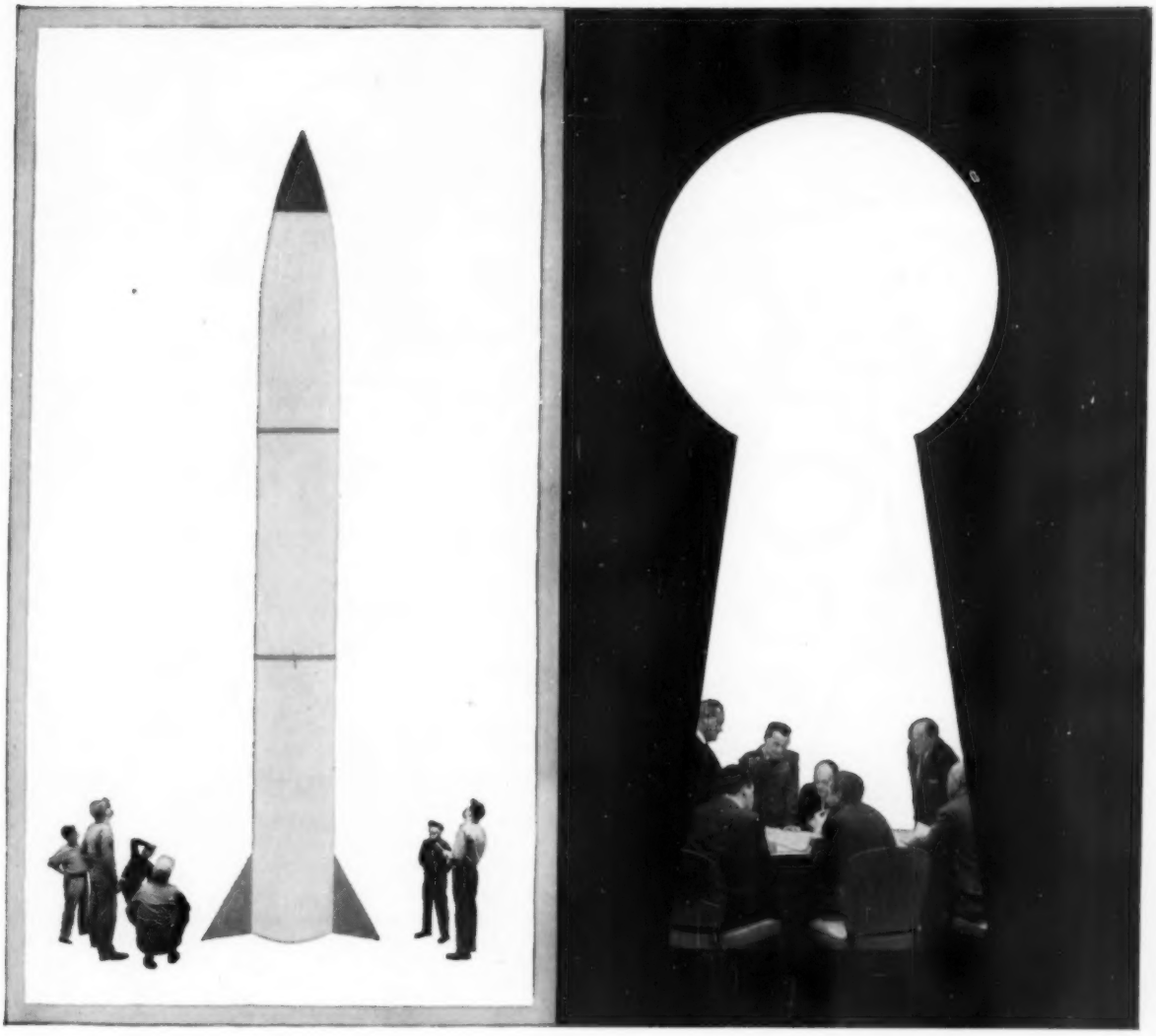
New Titanium Facilities.—New facilities will also bring titanium metal into greater supply, but with the sheet metal selling at $15 or more a pound titanium is being used only sparingly in nonmilitary products. But its superior chemical resistance to some chemicals compared with high-alloy steels has made it economical to use for valves and processing vessels in spite of high first cost. The problem of cost reduction now centers more on the difficulties in working the metal than on original production of the sponge.

Titanium even at moderately high temperatures dissolves all elements other than the inert gases, and once the metal has been contaminated it is difficult to reclaim it. Unless the metal is forged in a closed atmosphere of inert gas it absorbs oxygen and hydrogen, which diffuse inward and lower the mechanical properties. More than 150 parts per million of hydrogen leads to failure of the metal.

The Air Force wants titanium with no more than 125 parts per million of hydrogen, and this is difficult to attain. One producer states that in working the metal, around forty per cent is rejected and goes back as scrap for remelting.

One method of protection from contamination being tried is to coat the billets with aluminum. *Battelle Memorial Institute* has been working with the Air Force on a method of cold extrusion under high pressure by treating the billets in a phosphate fluoride bath and coating with a molybdenum disulphide lubricating compound.

With 5 producers now operating, the 1956 production of titanium sponge metal may be about 13,000 tons, probably more



From V-2 type to Talos

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● From the earliest missile types to the latest and most advanced developments, AMF has made major contributions to America's missile programs ● And today AMF is actively participating in *more than half* the programs under way ● One of its subsidiaries, Associated Missile Products Corporation, is the only private company devoted solely to missile support equipment. And AMF's missile activities cover practically every stage of design, development, and production . . . including mechanical and electronic test equipment . . . auxiliary power supplies . . . field and depot handling equipment . . . launchers . . . ground and flight control systems ● See for yourself why AMF's experience in missiles, as well as in a host of other fields, has made it the "can do" company.

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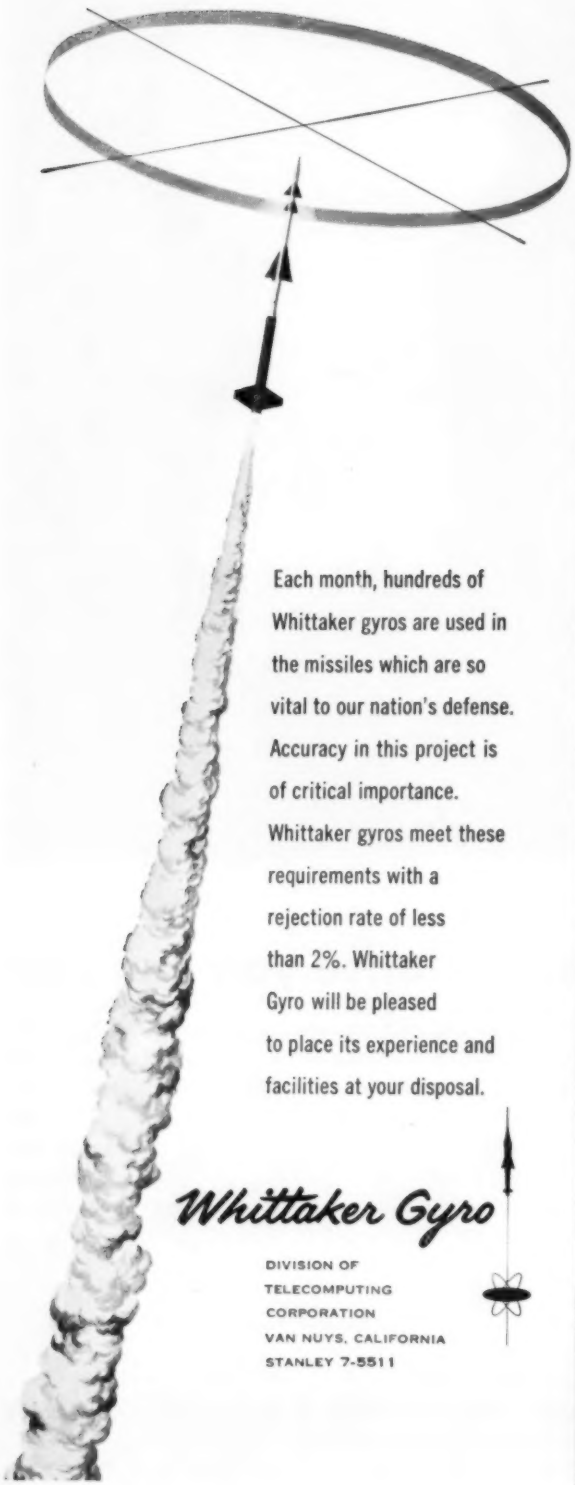
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Materials Progress (Contd.)

than ample at present prices for the finished metal, but small in comparison with prospective needs at more economical prices.

New Insulation Method.—To get away from the slow process of vacuum impregnation in the manufacture of electric insulation, *General Electric Company* has developed a process that will impregnate any semiporous material with resin or varnish by application of ultrasonic waves. The waves are beamed through the impregnating liquid, and the material to be treated is passed through the wave path in the liquid. The method can be used for impregnating cloth or paper as well as other materials.

Treating Teflon.—The slippery and antiadhesion surface of Teflon is ideal for lining pans, hoppers, tanks, and conveyor belts for handling powdered or sticky materials since the materials do not adhere to the surface. But it has been difficult to cement Teflon sheet to metals or wood with conventional adhesives. Now, *E. I. du Pont de Nemours & Company* offers a method of treating Teflon so that it can be cemented easily with commercial adhesives. The Teflon surface is first cleaned with acetone, then treated in a bath made by dissolving metallic sodium in liquid anhydrous ammonia. The bath strength is about one per cent.

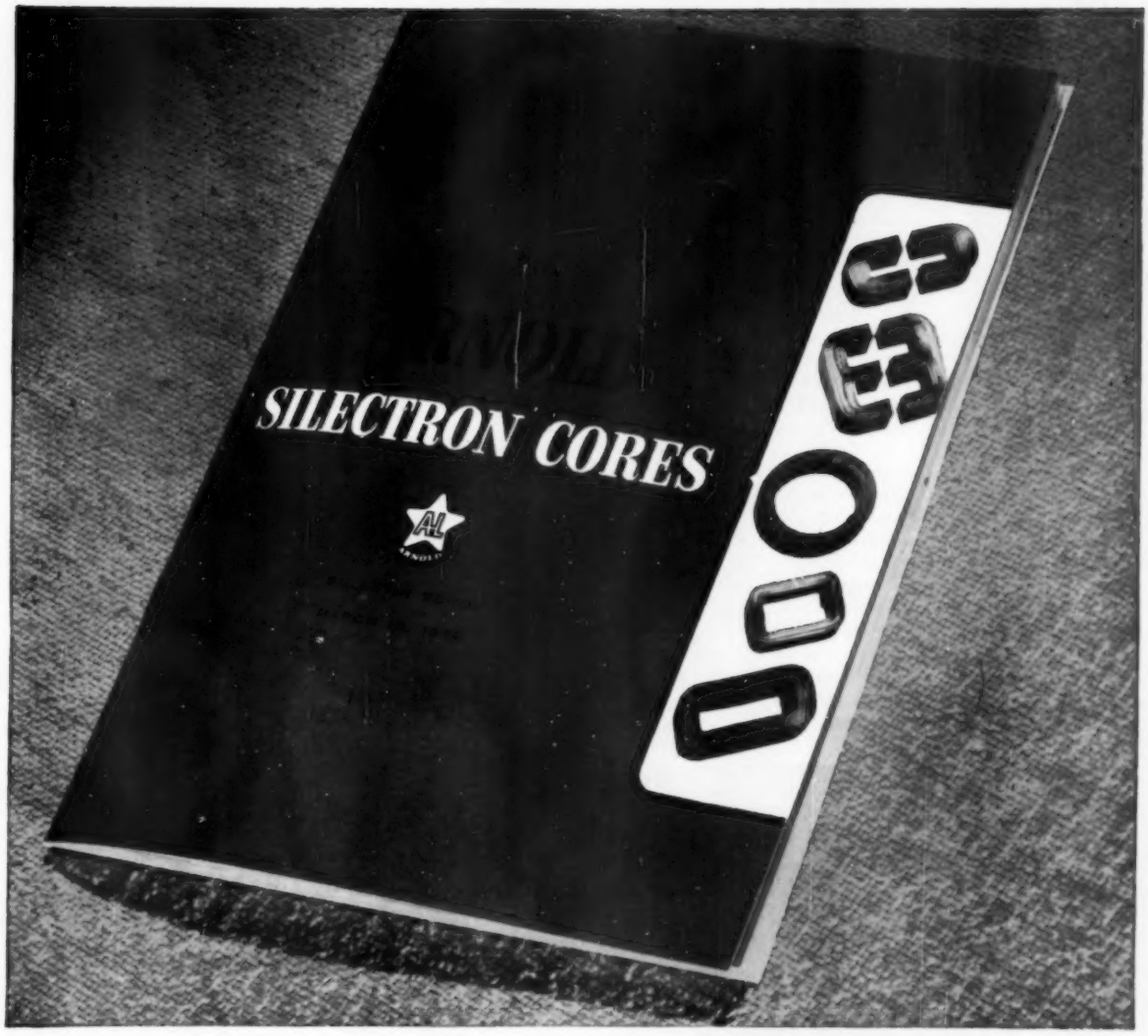
United States Gasket Company, Camden, N. J., is now marketing already treated cementable Teflon tape and sheet for lining purposes. The tape comes in rolls 12 inches wide in thicknesses of 0.005- to 0.060-inch. Sheets are 1/32- and 1/16-inch thick, up to 48 by 48 inches in size.

New Bearing Lubricant.—For bearing lubrication in industrial equipment where there is exposure to strong acids and chemicals, the *Scientific Glass Apparatus Company*, Bloomfield, N. J., has a new lubricant, called Kel-F-90, that will resist the action of the chemicals and will not wash out with water. It is a fluorocarbon plastic solution, is water-white in color, and is good for temperatures between zero and 350 degrees Fahrenheit.

Aluminum Welding Cable.—The new Type D-866 welding cable of the *General Cable Company*, New York, N. Y., is of aluminum and is only half the weight of conventional copper cable. It is made of No. 30 AWG electrical-conductor grade aluminum wires assembled in rope lay free from kinking. An overlapped separator tape is applied over the conductor, and the insulation is then the standard vulcanized rubber. A range of sizes is available.

Nylon Conveyor Tracks.—To eliminate the troublesome job of keeping bottle and can conveyor tracks lubricated in beverage plants, *Fenco, Inc.*, Chicago, Ill., designed a conveyor with nylon tracks and nylon link chains. The track, 1/16-inch thick, has mortise tenon joints to allow for expansion and is equipped with nylon pins to attach to the steel frame. The links are of the conventional type but have nylon plates attached in which the bottles or cans ride. The nylon requires no oiling, and the nylon links move smoothly without the jerking motion usual with metal conveyors, thus eliminating the tipping or overturning of bottles.

Aluminum Hangar Roof.—Aluminum alloy (Alclad 3004-H-16) corrugated sheet, 0.032-inch thick, was used to cover two of the world's largest aircraft hangers at the Lakehurst Naval Air Station. The area covered in the two 175-foot-high buildings is nearly a million square feet. The decking was first covered with 30-pound asphalt-impregnated abestos felt, and the aluminum sheet, with laps of six and eight inches, was fastened with Type 305 stainless-steel screws, calculated to stay tight under 120-m.p.h. winds. A total of 520,138 pounds of aluminum alloy was used in the reroofing project which was done by *Elwin G. Smith & Company*, Pittsburgh, Pa. (*Continued on p. 106*)



Here it is—the *Technical Data* on SILECTRON CORES . . . all shapes and sizes

This new bulletin contains design information on Arnold cores wound from a grain-oriented silicon steel, Silectron. Curves showing the effect of impregnation on core material properties are published for the first time. This 52-page bulletin includes information on cut "C" and "E" cores, and uncut toroids and rectangular shapes. Sizes range from a fraction of an ounce to more than a hundred pounds, in standard tape thicknesses of 1, 2, 4 and 12 mils.

A new method of tabulating core sizes is introduced, whereby cores are listed in the order of their power-handling capacity. You'll find this Silectron core bulletin a valuable addition to your engineering files—*write for your copy.*

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Materials Progress (Contd.)

Plastic-Coated Yarn.—A new Teflon-coated glass yarn produced by the *L.O.F. Glass Fibers Company*, Toledo, Ohio, has the fibers coated with the plastic before braiding into yarn to give a product with greater abrasion and corrosion resistance. It is designed for coaxial cables and for protecting cables for aircraft and naval applications.

New Pumps.—A new line of single-stage centrifugal pumps for handling corrosive liquids made entirely from Illium G, a high nickel-chromium-molybdenum alloy, has been announced by *Ampco Metal, Inc.*, Milwaukee, Wis. The pumps come in several sizes with capacities to 600 gallons a minute with a head of 150 feet.

Nickel Stainless Steel.—As an example of the use of nickel stainless steel where it is difficult to find an adequate substitute, the stillage evaporators of the *Hiram Walker & Sons, Inc.*, plant at Peoria, Ill., each have 908 two-inch tubes 84 inches long. The exterior of the tubes is exposed to vapors containing organic acids at 212 degrees Fahrenheit, and the interiors are exposed to spent stillage with 3 per cent solids to be concentrated to 30 per cent. Each week the tube insides are cleaned with 4 per cent caustic and then neutralized with acid. The Type 304 stainless-steel tubes now used last indefinitely and make for economical operation.

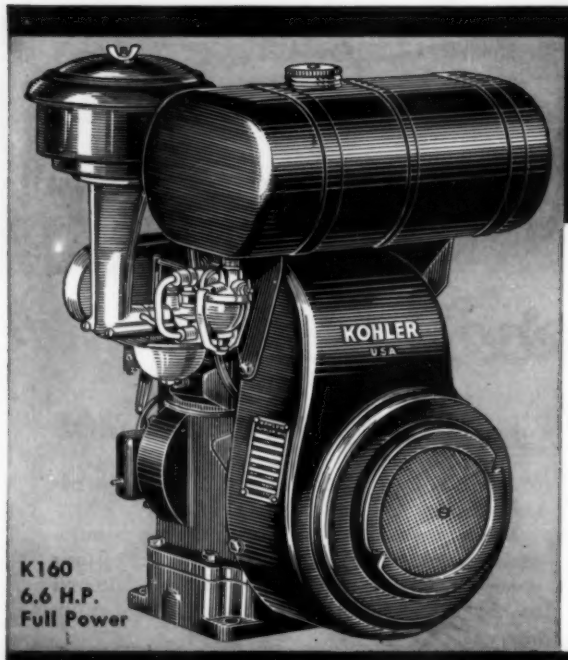
Aluminizing Valves.—To give longer life to engine valves and reduce deposits in the valve seats, *General Motors Corporation*, is aluminizing the valves by spray-metallizing the faces with aluminum and then heating to 1,450 degrees Fahrenheit to diffuse the aluminum metal into the steel to give an iron-aluminum alloy surface from 0.0008- to 0.0015-inch thick. This iron-aluminum surface is highly resistant to the corrosive effect of hot gases, and the wear life of valves has been practically doubled.

Electroluminescence.—Electroluminescence has recently been the subject of much study at the *Naval Ordnance Laboratories* and, although the results have not yet been published, great possibilities are foreseen for a better type of lighting. Present sulphide phosphors activated by copper or manganese are satisfactory for directional signs, but they do not have enough brilliance for other lighting purposes. The new direction of research is toward entirely new phosphors that can be imposed on plates or walls and be given the high brilliance necessary for lighting by activation with an electric current.

Aluminum Sheathing.—Aluminum may eventually replace lead as a power-cable sheathing as evidenced by a trial on two 4,160-volt transmission lines of the *Niagara Mohawk Power Company* at North Tonawanda, N. Y. The aluminum sheathing is six times stronger than conventional lead sheathing with only one-fifth the weight. The wipe-soldered joints used in lead sheathing have been eliminated by a unique system of cable clamps and 32-inch-long aluminum alloy 3003 splicing sleeves attached to aluminum bell shapes welded to flared sheath ends.

Golden Aluminum.—A new method of giving aluminum a permanent gold color without the use of dyes has been developed by the *Kaiser Aluminum & Chemical Corporation*, Oakland, Calif. The color is added to the molten aluminum, but this does not change the normal color of the metal. However, when the finished product is anodized the aluminum takes on the gold color which may be varied from pale straw to a deep gold bronze. The finish resists exposure to light and does not fade, and it increases corrosion resistance. The new aluminum will be available in sheet form.

(*Continued on p. 108*)



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The RV-A-10 missile, developed jointly by the Army Ordnance Corps, General Electric, and Thiokol Chemical Corporation, is an example of technical progress in solid propellant rocketry. The rocket motor for this missile was designed and developed by the Thiokol Chemical Corporation. Its successful flight tests definitely established the feasibility of "Thiokol" solid propellant power plants for use in large, long range and high altitude missiles.

Development of the power plant for the RV-A-10 stems largely from Thiokol's "systems" concept of rocket motor development. Under this concept of rocket motor design, all of the requirements of the missile are taken into consideration before the propulsion unit is put on the drawing boards. The motor's thrust, duration, size and shape are all governed by the specific application for which the unit is intended.

Close coordination is conducted with the missile prime contractor to consider problems such as aerodynamic stability, center of gravity requirements, guidance system impact and vibration resistance, wing and fin attachments, and other over-all missile problems.

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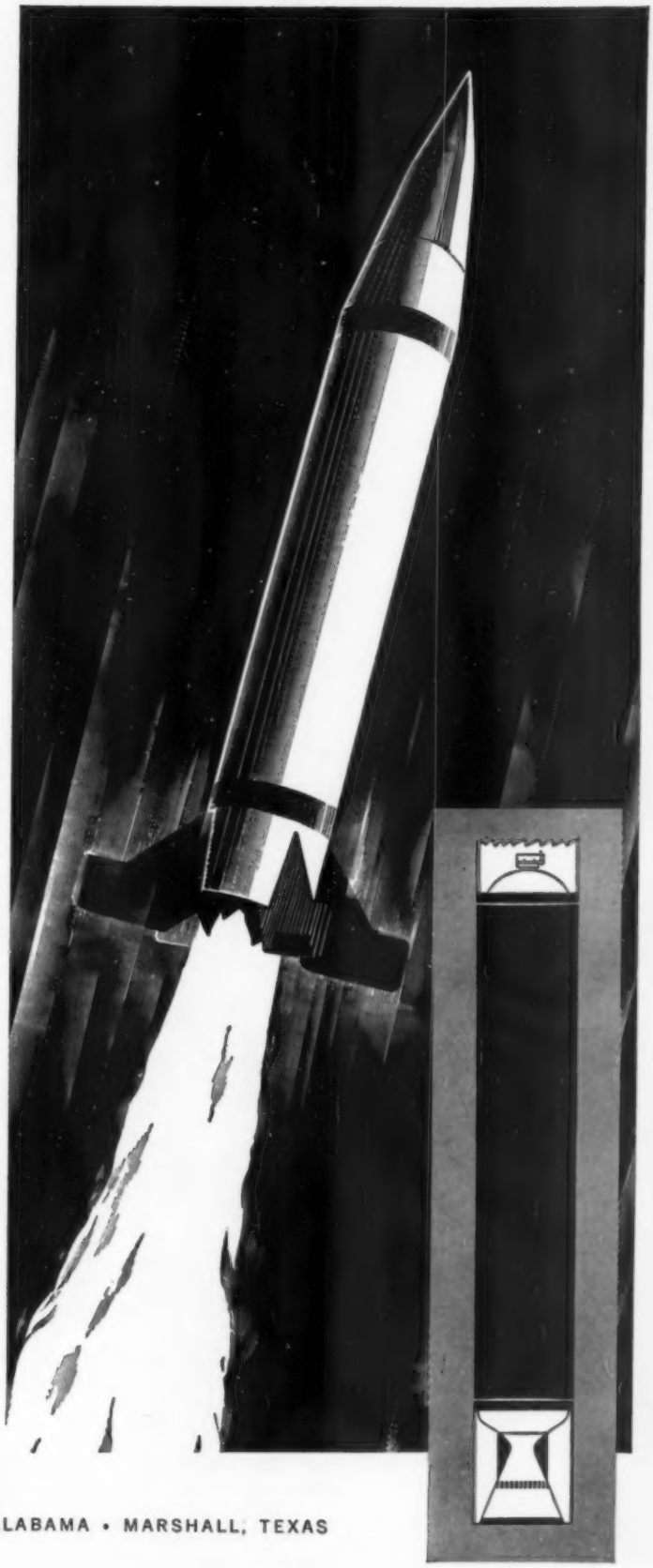

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Materials Progress (Contd.)

Nickel Alloys.—Illustrative of the increasing use of nickel in this atomic and jet engine age are two new alloys of *Coast Metals, Inc.*, Little Ferry, N. J., designed for brazing rocket nozzles and for welding and hard-surfacing jet-engine components. They contain 3.5 to 5 per cent silicon and 1.9 to 3.5 per cent boron with the balance nickel. Their flow points are around 1,900 degrees Fahrenheit, and the weld material is extremely hard and corrosion-resistant.

Corrosion Protection.—For the economical protection of tanks, bench tops, ducts, and chemical processing vessels against corrosion attack, the *M. W. Kellogg Company*, New York, N. Y., has a new thin sheet material, about 0.012-inch thick, made from glass cloth laminated with Kel-F fluorocarbon plastic. The sheets can be bonded to flat or contoured surfaces with an adhesive, and will protect the metal from hot or cold chemicals.

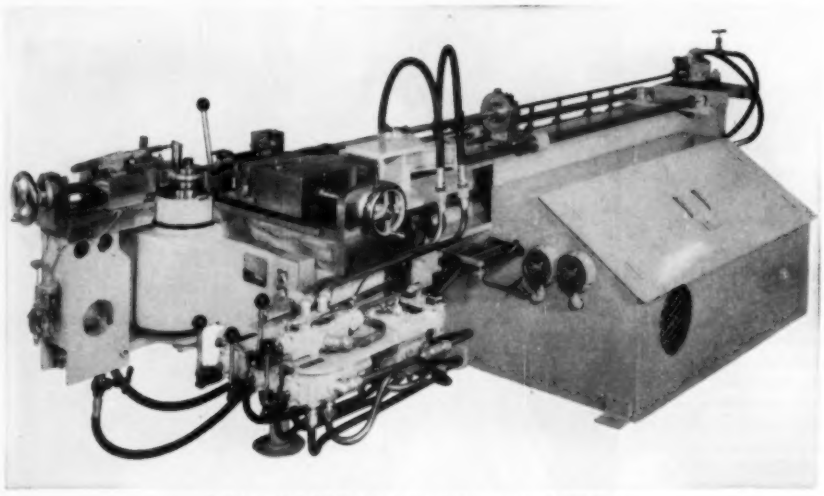
New Type Railway.—A new type of railway has been built for exhibition purposes in a Houston, Tex., park. The railway is only 970 feet long and consists of a single steel rail suspended 18 feet above the ground. The 54-foot passenger coach, made almost entirely of fiber glass and solar glass, is carried by eight 8.25-15 tires (*Goodyear Tire & Rubber Company*) which provide the traction from two 305-horsepower gasoline engines, and there are also twenty 4.00-8 rib trailer tires serving as rail guides. The coach travels with practically no noise or vibration. The system, if installed between cities for high-speed passenger travel, is claimed to cost only $500,000 a mile compared with about $5,000,000 per mile for freeways.

Porous Filter Elements.—By a newly developed process of powder metallurgy, *Purolator Products, Inc.*, Rahway, N. J., is now producing porous filter elements in practically any intricate shape including radial fin convolute constructions, and wall thicknesses as small as 0.015-inch may be had. Pore sizes may be from 2 to 25 microns. Types of metals used include stainless steels, Hastelloy, Monel metal, and nickel. With Type 302 stainless steel, the tensile strength of the filter with 30 per cent porosity is 36,000 pounds per square inch, and with 50 per cent porosity it is 7,500 pounds per square inch.

Nylon Fittings.—For use with aluminum or copper piping, the *Imperial Brass Manufacturing Company*, Chicago, Ill., is producing 2-piece fittings of nylon that need no flaring of the tubes and will withstand pressures to 500 pounds per square inch. The fittings, called Nylo-Seal, have a sleeve on the body that hugs the tube tightly when the nut is tightened. Sizes are ¼- to ½-inch in unions, elbows, and tees. They are resistant to acids and alkalies, and are recommended for use in chemical and food-processing plants.

Hard Wax Coatings.—Two white mineral waxes of high melting points and extra hardness, made in Germany by Krupp Kohlechemie, are being offered in this country for coatings and other uses by the *Dura Commodities Corporation*, New York City. Designated as FT-200 and FT-300, they are aliphatic hydrocarbons of high molecular weight, and have densities of 0.925 and 0.933, with melting points of 212 and 221 degrees Fahrenheit and flash points of 424 and 536 degrees Fahrenheit, respectively.

All-Aluminum Trains.—Two all-aluminum passenger trains of special design have been built by the *Pullman-Standard Manufacturing Company*, one for the New York Central and one for the New Haven Railroad, in an effort to regain the railways' competitive position in passenger traffic. The design differs completely from that of conventional steel cars. Most of the underframe and all of the superstructure and outer skin are of aluminum.



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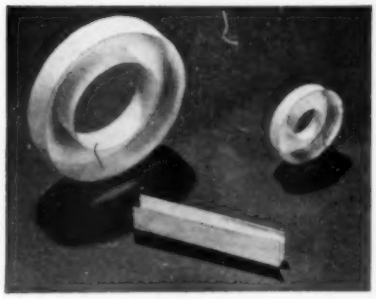
ELECTRICAL AND ELECTRONIC NEWS No. 6



Class H Silicone-glass Parts Save Space, Speed Assembly

Excellent post-formability of parts made with Dow Corning silicone bonded glass cloth contributes to growing market developed by Stevens Products, Inc., East Orange, N. J. Such parts cut assembly time, save space, give long service at Class H temperatures in motors and generators.

Custom-designed to displace assemblies that are normally taped, Stevens Products has developed a variety of post-formed silicone-glass laminated parts that eliminate seams, give more reliable performance and save assembly time and labor. A 2-ply interpole assembly, for instance, involves only two parts compared to six parts and the taping operation previously required. Over 1 million of these assemblies have been manufactured to date for use in generators.

Other post-formed silicone laminated parts include rotor covers, end caps, shaft collars, slot liners and bobbins, as well as insulating covers for a wide variety of electric and electronic parts. Rigid rectangular or circular tubing is also fabricated for transformers. Many of these parts involve complex configurations and deep draws. *No. 23*

Silicone dielectrics most widely used are described in the 1956 Reference Guide to Dow Corning Silicone Products. The brief but comprehensive description of each material includes a review of properties and applications. With increasing demands for high temperature operation, such a guide to these remarkably stable dielectrics should be immediately available to every electrical and electronic engineer. *No. 24*

AIRCRAFT WARM-UP TIME REDUCED BY SILASTIC INSULATED HEATERS

Meeting more closely than any other material the requirements of an ideal dielectric, Silastic* has proved its superiority in many applications ranging from traction motors to wire and cable. Here, for example, is how Silastic "R" Tape is used by Safeway Heat Elements, Inc., Middletown, Conn., to produce a line of woven resistance wire heaters that meet the demand for faster aircraft warm-up.

These heaters are made in a wide range of shapes and sizes for easy application to aircraft instruments which must be brought quickly to correct operating temperatures. The heating element is sandwiched between single layers of Silastic R Tape. The assembly is then vulcanized to form a void-free, moisture-proof jacket with maximum flexibility, minimum thickness and high thermal conductivity. Lead wires are insulated with a Silastic impregnated sleeving (Turbo 117) made by William Brand.

Single and double circuits are available in watt densities ranging up to 40 watts per square inch. Double circuits over the entire area assure fast warm-up and continued warmth.

Safeway heaters may be tied, bonded, snapped or bolted into position. Typical applications include gyros, bearings, cameras, valves, hoses and pitot tubes. Such heaters are also immersed in fluids that must be quickly heated or maintained at optimum operating temperatures.

Although surface temperatures of many of the thousands of heater units now in service exceed 450 F, not a single failure of the Silastic insulation has been reported.

*T M REG U S PAT OFF *No. 26*

OVEN-HOT AIR USED TO COOL SILICONE INSULATED EQUIPMENT

Cool electrical equipment with air that has a temperature of 250 F? Yes you can, providing the equipment is protected with Dow Corning silicone insulation. Here's how Westinghouse engineers put 250 F air to work cooling their new 40 kva, 400 cycle alternators or a-c generators for jet planes.

When a jet plane is hurtling through low altitude atmosphere at the speed of sound, air available for cooling purposes may have a temperature as high as 250 F. Far from cooling organic electrical insulating materials, these high ambients cause them to burn up in short order. At high altitudes, air temperature drops to —70 F, but the air is so thin, it has less heat-absorbing power than at low altitudes.

That's why Westinghouse uses silicone (Class H) insulation in their jet plane alternator. Operable at temperatures in the range of 480 F and higher, the silicone insulation is actually cooled by air hot enough to cause rapid failure of ordinary insulating materials.

To provide maximum cooling effect at any altitude, the Westinghouse alternator is fitted with a cone and hood combination that directs air to the critical pole and rear bearing areas. Because of its exceptional oxidation resistance and thermal stability, Dow Corning 44 Grease is used to lubricate the bearings. *No. 25*

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ROCKETS AND GUIDED MISSILES

Alfred J. Zaehringer

Astronautics.—Four more contracts for components of the U. S. satellite vehicle have been announced. The Allegany Ballistics Laboratory (Hercules Powder Company), Cumberland, Md., and Grand Central Rocket Company, Redlands, Calif., are to design, develop, and furnish the third-stage solid-propellant rocket for the Vanguard Project.

The small rocket will be spin-stabilized and will carry the actual satellite to its final orbit. The rocket will be guided into the proper orbit by a magnetic amplifier autopilot built by Vickers Electric of St. Louis, Mo. Meanwhile, Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., will build a 3-axis gyro system for the first two stages.

Size estimates of the actual satellite now range up to twenty pounds maximum. However instrumentation will vary from vehicle to vehicle. It is now predicted that the satellite orbit will be far from circular. Angular launching errors during each successive firing will result in an eccentric orbit which may carry the satellite as far as 800 to 1,200 miles from the earth and as close in as 100 to 200 miles.

This orbit will result in a reduced satellite life—possibly as low as a few days or as high as a few weeks. A recent announcement to Congress stated that the first launchings—originally scheduled for 1957—will be delayed until 1958.

There is now the possibility that the United States Air Force will attempt an individual satellite project on a much smaller scale than Vanguard. The modest project will attempt the firing of small multistage solid-fuel rockets from Skyhook balloons at an altitude of about 100,000 feet. Meanwhile, the Navy has been experimenting with the possibility of achieving satellite orbits by firing small rockets from high-flying, high-speed jet aircraft.

Missiles.—Engines for our intercontinental ballistic missile (ICBM), the *Atlas*, are under development at North American Aviation's Santa Susana, Calif., rocket test facility. At recent public firings, thrust ratings of Atlas-type rocket motors were estimated at 100,000 to 200,000 pounds. This compares with the German V-2 rocket motor which developed about 56,000 pounds of thrust. The turbopumps alone for Atlas equal the power of a modern locomotive in a package about the size of a football.

Another ICBM, the *Titan*, is to be produced for the Air Force by Glenn L. Martin Company at Denver, Colo. Britain has also announced start of work on its ICBM, and a test site is being prepared near the Scottish border. Top Soviet leaders have also announced that they are working on an ICBM which could deliver a hydrogen bomb.

Our efforts with the intermediate-range ballistic missile (IRBM) are also being intensified. The Army-Navy IRBM which can be launched from shipboard is called *Jupiter*. The Jupiter is to be developed by Chrysler from the *Redstone* missile program.

Our second IRBM is the Air Force *Thor* missile. Thor is under development by Douglas Aircraft. General Electric is to be responsible for the warhead while North American Aviation will develop the rocket engine and AC Spark Plug will furnish guidance.

The *Snark* has been unveiled by the Air Force as a cruise missile of intercontinental capabilities. Built by Northrop Aircraft and designated as SM-62, Snark has been flown over 2,000 miles from the Long Range Proving Ground in Florida. The missile is powered by a turbojet engine and is launched by means of two powerful booster rockets. The craft features swept wings and a long, cigar-shaped fuselage. With some components machined to extreme tolerances, Snark uses a precise and jamproof celestial guidance system. Ranges of up to 5,000 miles have been mentioned for this unmanned cruise missile.

Two other cruise missiles also have been in the news. The Navy *Regulus* has been successfully launched from the submarine U.S.S. TUNNY in tests off the California coast. The Air Force has revealed a new version of its *Matador* missile—the TM-61B. The new missile is longer and carries a larger nose section than present models. For tactical missions, the TM-61B will be given an entirely new airborne guidance system.

More effective operation of the *Nike* defense system is promised by the Army's new Missile Master (MM). Prototype of MM has been in operation at Fort Meade, Md., for almost two years. Additional systems are to be built by Martin at other key installations. *(Continued on p. 112)*

Expediting development of an inaccessible area with helicopter... in transporting men, machinery, material.

World's Largest Turbo Transporter

Pours Out Its Power Through SPECO Transmissions

This mammoth turbine-powered helicopter of "1001" uses is the Vertol YH-16A. The production version will be able to carry up to 12 tons and can whirl into action without warm-up to achieve an air speed of over 150 mph. Transferring the output of its turbine into a smooth, steady flow of propelling power is the job of the forward and aft transmissions produced by SPECO, the Steel Products Engineering Division of Kelsey-Hayes.

The manufacture and assembly of gears and gear assemblies which insure dependable, maintenance-free performance such as required in the Vertol YH-16A is a Speco specialty, one of 40 years standing in service to the aviation industry.

Rotor transmission from YH-16. The transmissions, clutch assemblies, synchronizing shafts and drive shaftings are produced by Kelsey-Hayes in accordance with Vertol's design specifications.

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How a **METAL IMPROVEMENT** *helps maintain B-52 production schedules*

• Here's the Boeing B-52 global bomber . . . flying 400 pounds lighter because the new metal titanium is used extensively in the jet engine pods. But in forming titanium parts, Bell Aircraft, one of the firms which produces the complete pod assemblies, originally encountered production delays because of variable "springback" in forming titanium sheets of different strengths.

To overcome this, Bell segregates titanium into different strength groups, which are color coded and handled separately with improved forming techniques. Here Mallory-Sharon's new "quality certification" of titanium proves a substantial time saver. With this method, we not only meet specifications, but certify average strength of each heat we produce, and certify that 97.5% of each heat is in a narrow range of this average. This eliminates the need for tests to segregate incoming material . . . helps cut fabrication costs . . . and permits meeting production schedules on time.

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Rockets and Guided Missiles

MM is a complete electronic system which coördinates and directs a large number of Nike batteries. Each system operates independently but can also operate in conjunction with the Air Force Sage (semiautomatic ground environment) area defense system.

MM gathers information of aircraft identity and location and displays it electronically. Each Nike battery thus receives fresh data. In addition, MM can coördinate and direct fire of all batteries.

Each Missile Master system is housed in a 2-story building which also contains the operations center where Army personnel at display consoles have a view of the over-all air situation in the local area as well as information on activities of the Nike batteries under their jurisdiction.

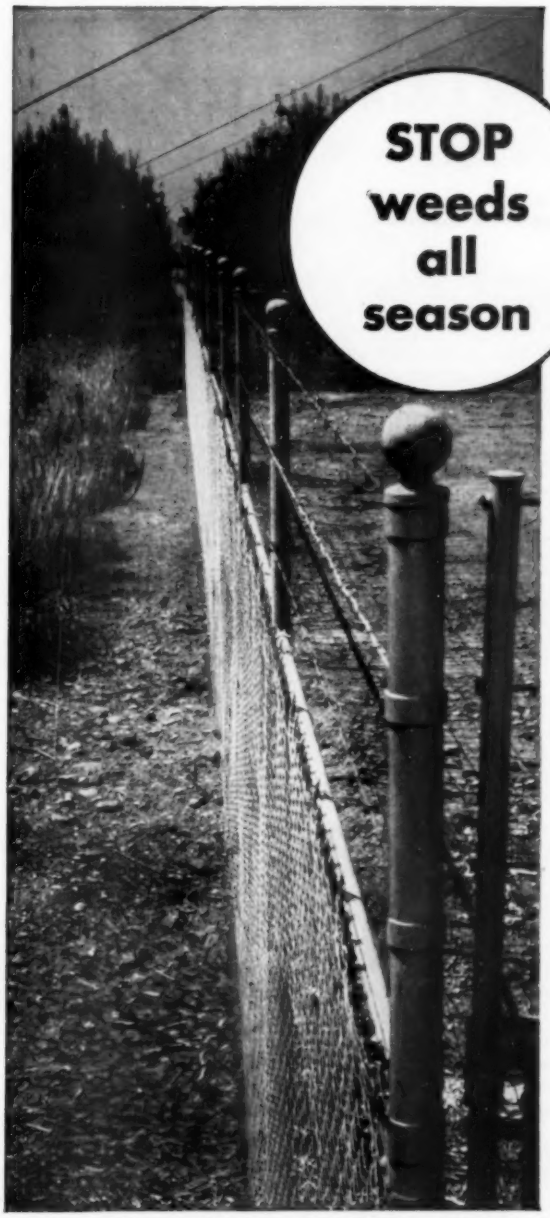
Research.—A "space chamber" at General Mills Mechanical Division, Minneapolis, Minn., has been in operation in simulating space conditions at altitudes of 80 to 300 miles. Ionized particles bombard metals at very high velocities to learn more about the disintegration or "sputtering" of metals under impact by molecules and free atoms. The study has shown that damage is not caused by the heat of the impact but is determined by the momentum of the particles and the angle at which they impinge.

High-altitude, high-velocity impacts are also being studied in a "strong" shock tube at the Armour Research Foundation, Chicago, Ill. The program is studying the damage that may be caused to guided missiles and satellites by the impact of airborne dust particles and heat caused by air friction.

A shock tube, using the detonation of gases, is used to shoot particles of dust against metal plates at speeds up to 4,000 feet a second (about 4 times the speed of sound). In the tests, copper plate, 0.008-inch thick, was penetrated by specks of common dust.

An Air Force research unit a Holloman Air Force Base, N. Mex., is to get a solar mirror which can generate temperatures up to 8,000 degrees Fahrenheit. The mirror will test the effects of intense temperatures on vital guided-missile and satellite components.

General Electric Company has released data which is indicative of the temperature problem in guided missiles. Skin temperatures were measured on a V-2 rocket which reached an altitude of 97 miles and speed of 3,400 miles an hour. Until about 30 seconds after launching the skin temperature was about 100 degrees Fahrenheit. After an additional 30 seconds temperatures climbed to nearly 550 degrees Fahrenheit, despite the fact that the air pressure had dropped to less than one psia.



Just one application of "Telvar" controlled weeds around this security fence. Note the type of vegetation involved in untreated area at left. "Telvar" is ideal for weed control around fences, railroad sidings, buildings and installations of all types.

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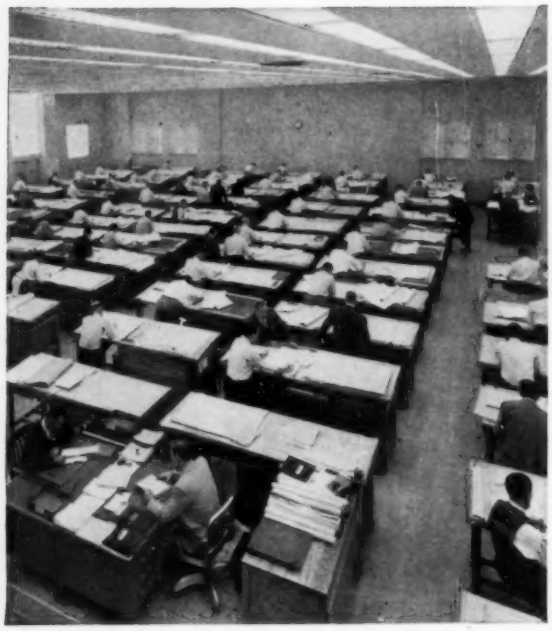

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ARMAMENT ELECTRONICS

Dr. W. S. Carlson

IN any future war, conduct of military operations on land will undoubtedly be influenced by the threat of nuclear weapons. Means of delivery now at the disposal of a field army include artillery, rockets, and guided missiles. Given competent intelligence and reliable communications, prerequisite to efficient employment, the advent of tactical atomic weapons appears likely to confer a significant advantage on the prepared defender.

Concentration by an aggressor of men and matériel within range of guided missiles would invite disaster. On the other hand, inability to deploy adequate force promptly in response to strong resistance, or failure to expand a narrow penetration quickly may expose the attacker to serious reverses.

In the field-artillery rôle, nuclear weapons have considerably extended the combat zone in depth. With movement of large forces by road convoy subject to interdiction, it may be necessary to rely on airborne units or on highly mobile combat teams and special mission companies able to negotiate difficult terrain. These forces would be capable of independent action or of rapid maneuver to execute a coördinated assault.

To cope with tactics of dispersion and maneuver, improved techniques are needed for battlefield surveillance. Formation at Fort Bragg, N. C., of a special company-strength reconnaissance unit was reported in the January-February 1956 issue of ORDNANCE. The new unit, organized to test innovations in tactics, is provided with helicopters, fixed-wing aircraft, jeeps, and tanks. Photography, airborne television, and radar were mentioned as aids to observation.

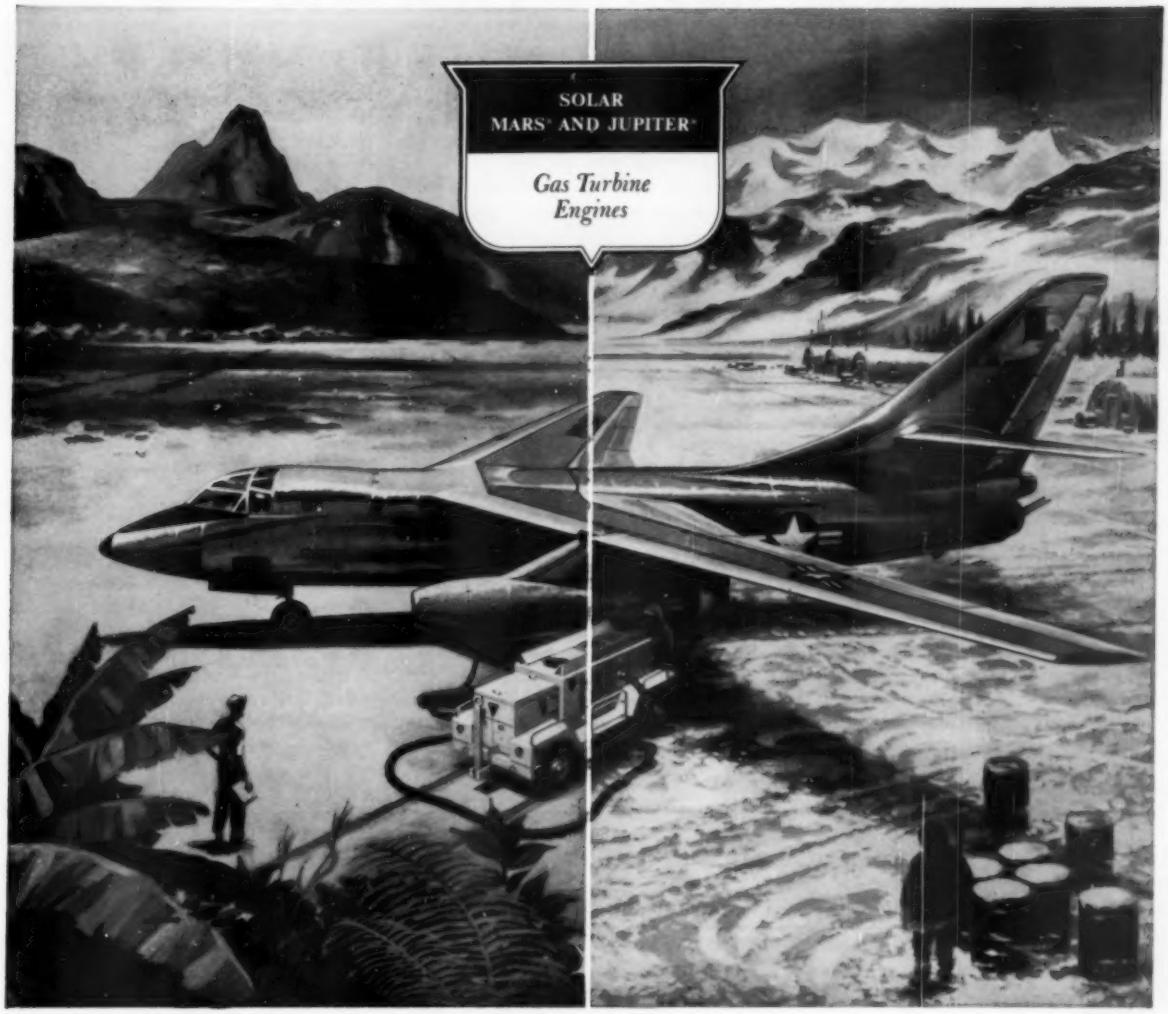
Radiation detectors and image converters sensitive in the infrared spectrum found military applications during the Second World War, and subsequent improvements have increased the usefulness of these devices. Several techniques for image intensification, commonly termed "light amplification," show promise for military surveillance applications. Multistage image converters may be used to give greater gain than can be realized from single-stage converter tubes of the type used in the familiar infrared-sensitive "Sniperscope."

The General Electric Company has recently demonstrated an intensifying screen based on electroluminescence. Development of a 1,029-line television system, the Lumicon, affording an image intensification factor of 40,000 has recently been announced by the Bendix Aviation Corporation.

Each of these techniques can be used to reproduce certain features of the environment for presentation as a visual display. It is a matter of practical importance to establish a valid basis for comparing performance of various alternative processes and equipments. A figure of merit for this purpose should be obtainable from a limited number of reproducible measurements and should correlate closely with performance of the equipment in the intended application.

The photographic process has been available in essentially its present form for seventy years. Aërial photography for reconnaissance and cartography was practiced on a large scale during the First World War. Nevertheless, specialists in photographic optics are by no means in complete agreement as to preferred quality criteria and test procedures for rating lenses and sensitive materials.

In part, this divergence reflects a difference in point of view between the lens user and the designer. The user seeks to specify optical quality in such a way as to minimize testing effort needed to ensure satisfactory performance in the intended application.



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The designer prefers a specification which is readily related to lens design parameters such as radii of curvature and glass characteristics.

Increasing availability of high-speed computing facilities has led some designers to propose that lens performance be specified in terms of energy distribution in the image of a point source. This distribution could be correlated with a mathematical model of the lens based on ray tracing.

THE armed services procure photographic objectives against a specification (MIL-STD-150) based on resolving power. The test object consists of parallel dark bars separated by light spaces of equal width. The smallest pattern for which the bar structure is reproduced in the image represents the limit of resolution.

Resolving power is expressed in units of reciprocal length, usually as lines (bars) per millimeter referred to the image plane. This criterion of image quality has proved reasonably satisfactory for evaluation of photographic objectives.

Unfortunately, resolving power is not easily correlated with design parameters nor can resolving-power data for single stages be combined in a straightforward manner to yield a figure of merit for a cascaded process such as facsimile transmission.

In order to deal with cascaded stages, particularly where a raster process is involved, Fourier treatment has been proposed. Because of diffraction effects, even a perfect lens does not reproduce a line target—*e.g.*, illuminated slit—as a line. The image consists of a bright central band with alternately dark and light bands extending to either side.

The periodic structure of a test object comprising a series of parallel lines will not be reproduced if the corresponding diffraction patterns overlap. The limit of resolution in lines per unit length may, by analogy with electrical network behavior, be regarded as the cutoff frequency of a low-pass filter represcnting the aperture.

In principle, any arbitrary signal function $f(t)$, can be represented as a frequency spectrum. If this signal is impressed on a linear network, the output also can be represented by a spectral distribution. The input-to-output relationship for any frequency component depends on the steady-state impedance of the network at that frequency.

In dealing with an image-forming process, the spatial distribution of intensity across the object may be treated as the analogue, $f(s)$, of a signal varying with time. Output of an optical process, the image, depends on the transmission function associated with the optical process. The transmission function of a filter can be ascertained by steady-state measurements for a sinusoidal input over the frequency range of interest.

Variable-density sound track recording affords a practical means for producing the desired test object. The optical system to be investigated is used to form an image of the test pattern. Illumination passed by a narrow slit in the image plane falls on the cathode of a photomult.plier. Output of the photomultiplier represents intensity for a line element of the image.

By scanning across the image the transmission characteristic of the optical process can be ascertained. In practice, it is more convenient to move the test pattern than to carry out the equivalent scanning operation by traversing the slit across a stationary image.

OUTPUT of the test operation is an AC signal at a frequency determined by the test pattern spacing in lines per unit length (line number) and scanning speed. As line number is increased, AC response declines until the limit of resolution is reached. It would also be possible to form the image under study on the face of an orthicon camera tube and accomplish the scanning electrically.

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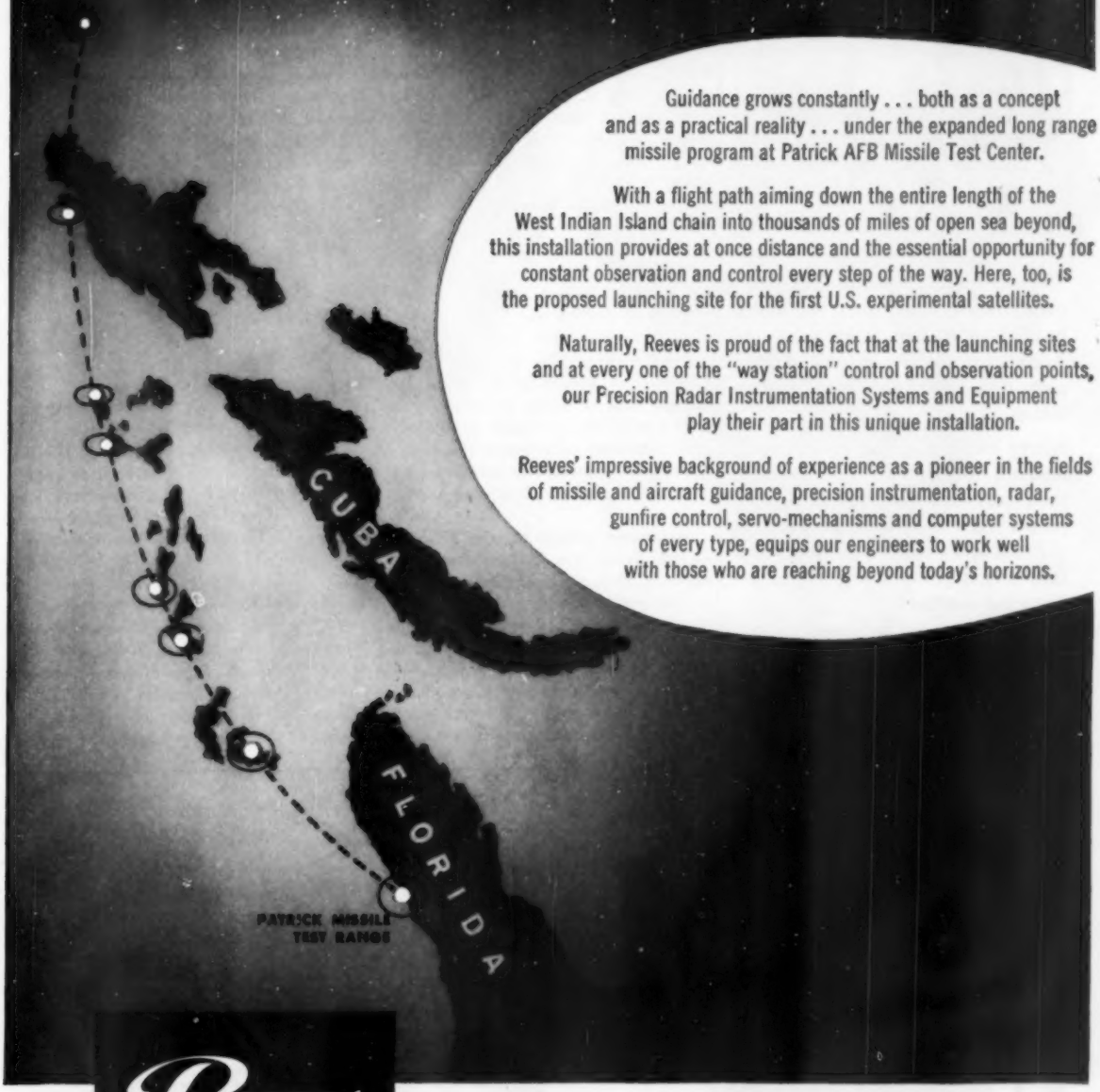

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With a flight path aiming down the entire length of the West Indian Island chain into thousands of miles of open sea beyond, this installation provides at once distance and the essential opportunity for constant observation and control every step of the way. Here, too, is the proposed launching site for the first U.S. experimental satellites.

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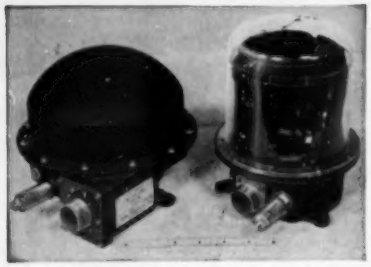

Photo Courtesy The Sperry Gyroscope Company

The Sperry Gyroscope Company uses Anderol lubricants for motor bearings and gimbal bearings, and damping fluids for control of gyro units and for control panel instruments.

Sperry found that the versatility of Anderol lubricants, together with their rust and corrosion protection properties, enabled the products to perform more uniformly. Relubrication was *only* necessary on normal servicing overhaul cycles.

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RECENT PATENTS

This department on recent military-industrial patents is being published in ORDNANCE *to keep our readers informed of the latest developments in these fields. The data are compiled by Melvin Nord, patent attorney, Detroit, Mich. Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each.*—THE EDITORS.

Airborne Radiation Detector.—*U. S. Patent No. 2,730,626. Issued January 10, 1956, to Frederick M. Varney:* This patent provides a lighter-than-air balloon containing a Geiger counter arranged to operate a radio transmitter when the counter is in a radioactive field. Its object is to provide early warning of the testing by other countries of atomic weapons.

Packaging of Explosives.—*U. S. Patent No. 2,734,623. Issued February 14, 1956, to Cecil R. Pullum and Thabus R. Harvey. Assigned to Olin Mathieson Chemical Corporation:* This invention provides a package of primers for ammunition and blasting caps in which the likelihood of a mass explosion as a result of detonation of an individual primer is minimized. The primers are packaged in individual cells formed of perforated paperboard sheets.

Ammonium Nitrate Blasting Explosive.—*U. S. Patent No. 2,736,262. Issued February 28, 1956, to James Taylor. Assigned to Imperial Chemical Industries, Ltd.:* According to the present invention a low-density safety ammonium nitrate blasting powder explosive composition is provided which contains dendritic sodium chloride having a bulk density of 0.9-1.7 gm./cc. as the flame-quenching ingredient.

Water-Resistant Explosive Assembly.—*U. S. Patent No. 2,733,658. Issued February 7, 1956, to Harry L. Moat. Assigned to Atlas Powder Company:* As shown in Figure 1, a shell 11 is turned over and folded so as to provide a floor 13 of a tray-shaped depression. Overlying this floor is a disk 15. Tube 17 extends through the assembly, serving as a tie member. Glued to the tube is a sleeve 19 extending over the disk 15.

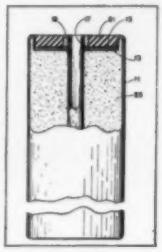

Fig. 1.

A waxlike seal 21 closes the end of the assembly against the entry of water. The opposite end is constructed similarly. Before closing one end, the shell is loaded with explosive 25. Water-sensitive explosives having low proportions of sensitizers are used, such as ammonium nitrate.

Aircraft Storage for Submarines.—*U. S. Patent No. 2,735,391. Issued February 21, 1956, to Herbert H. Buschers. Assigned to the Glenn L. Martin Company:* This invention provides storage and launching facilities for aircraft on submarines. As shown in Figure 2, a hangar

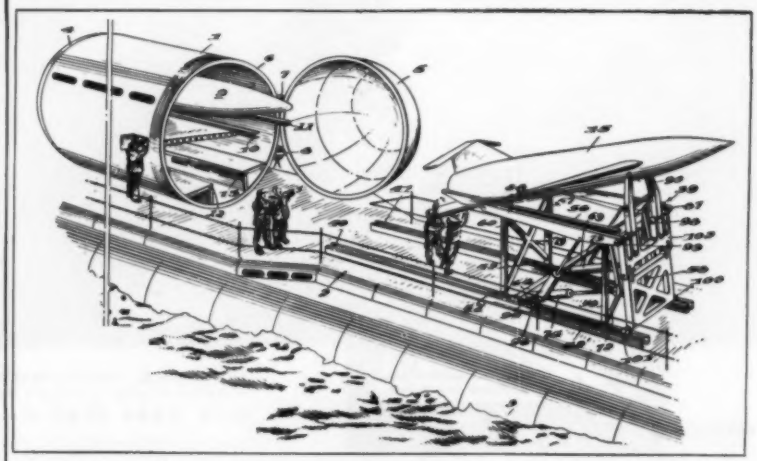

Fig. 2. Watertight aircraft hangar and launching platform for use on submarines.

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America's most potent protective weapon has been announced by the Army.

It is the new Martin Missile Master, the country's first electronic system designed to coordinate and control an integrated network of radar surveillance, target detection and anti-aircraft missile battery operation.

Now fully proved out and ready for installation, Missile Master offers pushbutton protection for whole cities and strategic areas.

The system collects information on the position, identity and flight data of all aircraft entering the network. This data is stored electronically and distributed to display consoles in the Operation Center and at the missile batteries.

Thus, the activity of Nike batteries and other advanced weapons in the system are centrally coordinated and controlled.

This important new weapon system is one of the great defense developments of our time.

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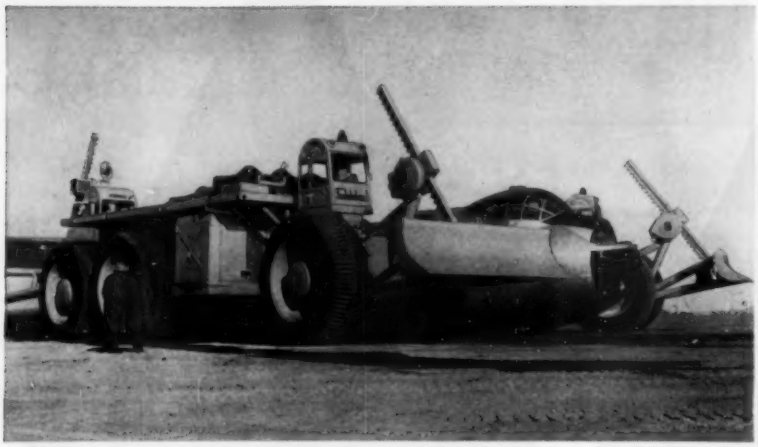

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Recent Patents (Contd.)

1 with a watertight door 5 is secured on the deck of the submarine. One aircraft 9 can be stacked above a second 15 in the hangar. The launcher moves on tracks on the deck. The aircraft are provided with auxiliary rocket booster motors for launching.

Sectional Fuselage for Aircraft.— *U. S. Patent No. 2,736,523. Issued February 28, 1956, to Herbert E. Chaplin. Assigned to the Fairey Aviation Company, Ltd.:* This invention provides a fuselage formed in two portions, a body portion and a nose portion, with a pivot connection between them permitting the nose portion to be inclined downward as shown in Figure 3. The object is to provide the pilot with a satisfactory view of the ground when taking off or landing.

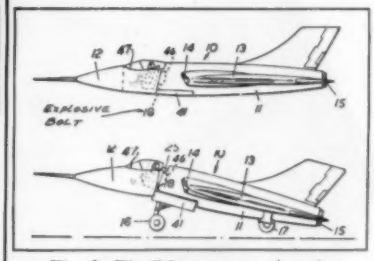


Fig. 3. Flexible nose on aircraft.

Underwater Acoustic Diaphragm.—*U. S. Patent No. 2,733,774. Issued February 7, 1956, to Leopold Pessel. Assigned to the Secretary of the Navy:* This invention provides materials for waterproofing loudspeakers which are to be used on the decks of submarines and which will prevent puncture of the loudspeaker diaphragm by near-by underwater explosions. It has been found that the rupture can be prevented by avoiding the entrapment of any air bubbles in the conventional waterproofing material. This is accomplished by using as the coating a water-insoluble hydrophilic material instead of a hydrophobic resin binder. Partially hydrolyzed polyvinyl alcohol is preferred as the coating material. The patent gives instructions as to how it can be prepared.

Dive-Bombing Breakaway Computer.— *U. S. Patent No. 2,736,878. Issued February 28, 1956, to Edward B. Boyle, Jr. Assigned to the Secretary of the Navy:* This invention describes a safety device which will emit a signal to inform the pilot of an airplane performing a dive-bombing attack of the minimum safe altitude at which to pull out of his dive. The invention is based on the use of a computer which utilizes the true airspeed, dive angle, and altitude of the aircraft to compute the minimum safe altitude for executing a pullout.

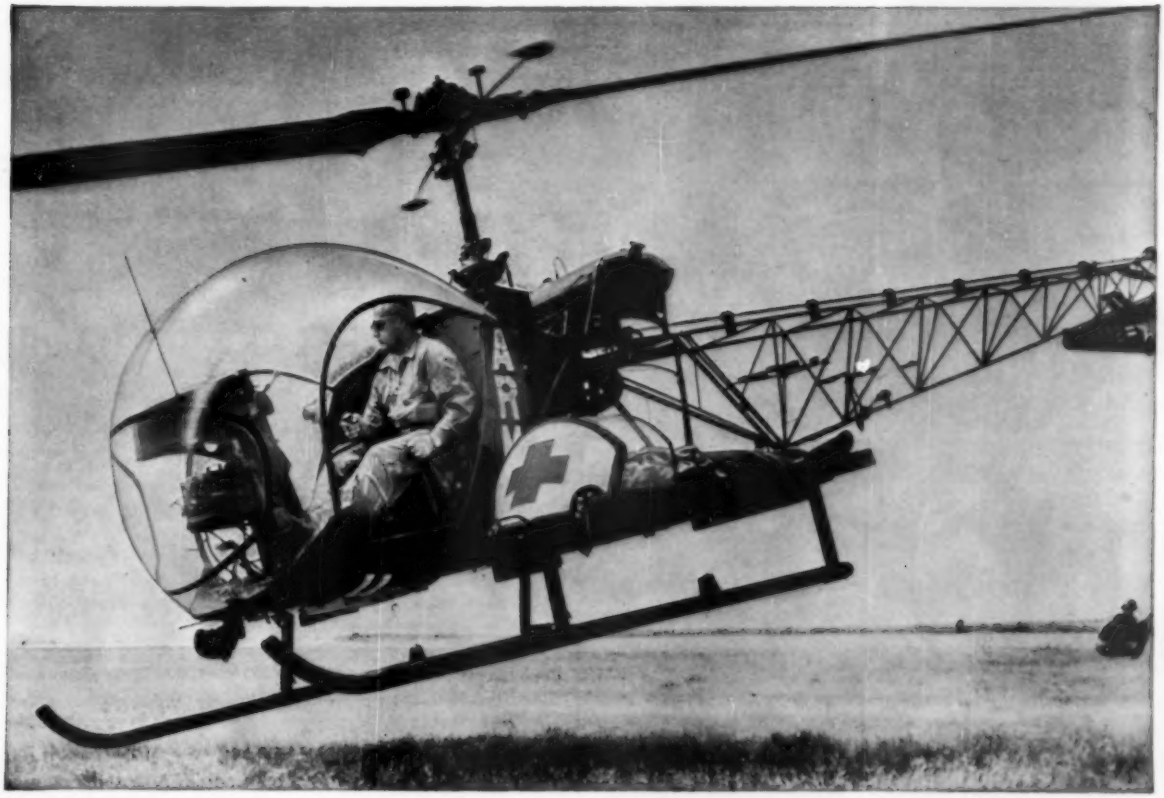
"Mr. Helicopter"

When Capt. William E. Brake evacuated *900 wounded men* in Korea, grateful soldiers inspired a very appropriate nickname for this U. S. Army pilot—"Mr. Helicopter."

Capt. Brake flew 587 missions in his Bell H-13 helicopter, often under direct fire from the enemy front lines, to bring his injured charges safely and quickly back to Mobile Army Surgical Hospitals. Some were so seriously hurt that evacuation by any other means of transportation would have been fatal.

A native of Lansing, Mich., Capt. Brake's present assignment is as a helicopter instructor at the Army Aviation Center, Fort Rucker, Ala., where he shares his vast combat and rotary wing experience with the Army's newest flying recruits.

Capt. William E. Brake
...Shares his experience



The U. S. Army has to fight wars but it is also dedicated to providing the world's best care for its injured combat troops. The helicopter, as Capt. Brake demonstrates above, guarantees the fastest and most comfortable "mercy missions." More than 25,000 men were "saved" by helicopters in Korea and the Army is relying more and more on rotary wing aircraft for this and other purposes.

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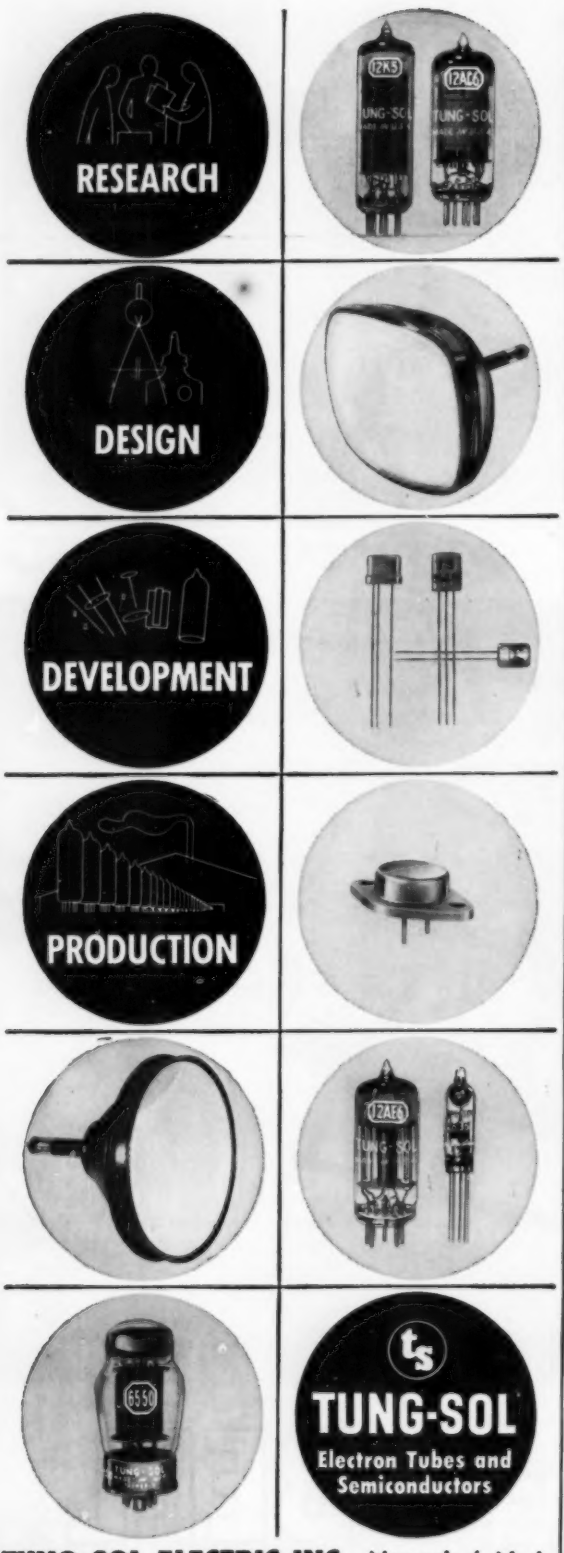

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Book REVIEWS

Reviews in this issue by:

COL. GEORGE S. BRADY, *consulting engineer, author, editor, Washington, D. C.*

L. A. CODD, *editor of* ORDNANCE, *Washington, D. C.*

DR. JAMES B. EDSON, *consultant on electronics, Research and Development Division, Office, Chief of Army Ordnance, Washington, D. C.*

F. W. FOSTER GLEASON, *military historian, ordnance analyst, editor, Washington, D. C.*

MELVIN M. JOHNSON, JR., *automatic arms expert, author, New Haven, Conn.*

BRIG. GEN. BURTON O. LEWIS, *U.S.A., Ret., ordnance engineer, former A.O.A. staff consultant, Washington, D. C.*

DR. ARTHUR F. MACCONOCHIE, *head of the mechanical engineering department, University of Virginia, Charlottesville, Va.*

PHILIPPE W. NEWTON, *deputy chief, guided-missile section, Research and Development Division, Office, Chief of Army Ordnance, Washington, D. C.*

ROBERT J. WARFEL, *staff consultant, American Ordnance Association, Washington, D. C.*

CAPT. J. M. P. WRIGHT, *U.S.N., Ret., naval ordnance engineer, logistician, editor, Washington, D. C.*

COL. GRATIAN M. YATSEVITCH, *nuclear engineer, Ordnance Corps, United States Army, Washington, D. C.*

The Machine Gun, Vol. IV. Compiled by Lieut. Col. George M. Chinn. Washington, D. C.: U. S. Government Printing Office. 638 pp. $6.50.

COMING "not as a stranger" to the subject of automatic weapons, their care and feeding, this reviewer salutes another of Colonel Chinn's machine-gun masterpieces, "The Machine Gun, Vol. IV"—a volume which indeed covers automatic gun mechanisms in great detail and with generous illustration. If you have any reason whatever for delving into this subject seriously, then "The Machine Gun, IV" is a must.

Those who propose any venture into the outer atmosphere of weaponry should read this volume on operation and mechanism details by Chinn, a distinguished Marine officer.

In conclusion, I again salute a volume which is so dedicated to the advancement of our scientific knowledge. It is a rare gift, requiring much sweat and many tears, to compile, even with the facilities of the Navy Bureau of Ordnance, such a source book in this technical field. Read "The Machine Gun, IV" if you really want to know the score.—MELVIN M. JOHNSON, JR.

Soldier: The Memoirs of Matthew B. Ridgway. By Gen. Matthew B. Ridgway, U.S.A., Ret., as told to Harold H. Martin. New York: Harper & Brothers. 371 pp. $5.

THIS volume bears a foreword by Gen. George C. Marshall who characterizes General Ridgway's service to the Army in these words: "General Ridgway has firmly established himself in history as a great battle leader." (*Continued on p. 124*)

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Book Reviews (Contd.)

The text fully carries out General Marshall's estimate. Throughout, it testifies to the high ideals of the American soldier—his devotion to duty and his unflinching courage under most adverse circumstances.

The broad scope of General Ridgway's service involves the momentous years from his days as a cadet at the United States Military Academy, which he entered in 1912. Thus the canvas embraces the broad panorama of the First World War, the years between the Second World War, the Korean Campaign, and the culmination of his service as Chief of Staff of the Army.

But it seems to this reviewer that no contribution by General Ridgway to the national defense was more timely than the summary chapters of his book which describe the function of the American Army in the nuclear age and his final report to the Secretary of Defense in which he outlined the needs of the Army as a factor of integrated defense.

Both these courageous statements will stand as models to guide administrators—civil and military—in their striving for balanced forces, realizing that upon the land army always descends ultimately the dangerous and difficult task of taking and holding ground in battle.—L. A. Codd.

Aërodynamics, Propulsion, Structures. By E. A. Bonney, M. J. Zucrow, and C. W. Besserer. Volume II in Principles of Guided Missile Design Series. Edited by Grayson Merrill. New York: D. Van Nostrand Company. $15.

HERE is the second volume of a projected series of six, the first one of which, entitled "Guidance," was reviewed in the September-October 1955 issue of Ordnance. In contrast with its predecessor, this volume is concerned solely with several aspects of the missile itself and not with the ground-, aircraft-, or ship-based equipment that help complete the weapon system.

The first part, entitled "Aërodynamics," is written by a member of Johns Hopkins University's Applied Physics Laboratory. Unfortunately, it limits itself to a number of oversimplifications and generalizations that will, it is feared, be unsatisfying to the average engineer.

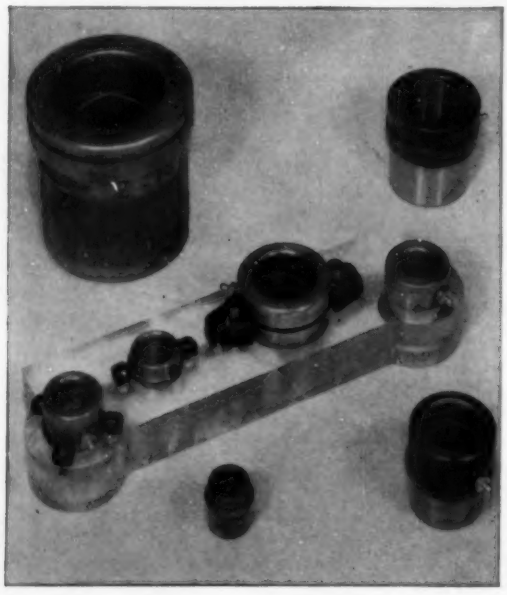
The second part, written by Prof. M. J. Zucrow, of Purdue University, is itself in two sections—the first including the fundamental theories of momentum, gas dynamics, and one-dimensional flow and the other comprising separate chapters on the turbojet, the ramjet, and rocket fundamentals for both liquid- and solid-propellant rockets.

The third part of the book, "Structures and Design Practice," authored by C. W. Besserer, a practicing engineer, is certainly the most unusual, and, because it gathers information never before published to this reviewer's knowledge in textbook form under one cover, it is thoroughly engrossing. For example it contains useful tabulated data on missile materials, aluminum and magnesium alloys, alloy steels, and titanium alloys. There are excellent chapters on design for environmental conditions of interest to missile engineers of any stripe; chapters on reliability concepts and on packaging.

If it succeeds (and it should) in impressing the average engineer with the tough environmental criteria, such as temperature extremes, humidity, shock, vibration, etc., that military equipment must be capable of withstanding, a real contribution has been made.—P. W. Newton.

Atom Harvest. By Leonard Bertin. London: Secker and Warburg. 253 pp. $2.80.

DEALING comprehensively with both the military and peaceful aspects of atomic energy as they affect Britain's place in the world, Leonard Bertin covers the field from the small wartime beginnings to the full-scale industry already in existence and



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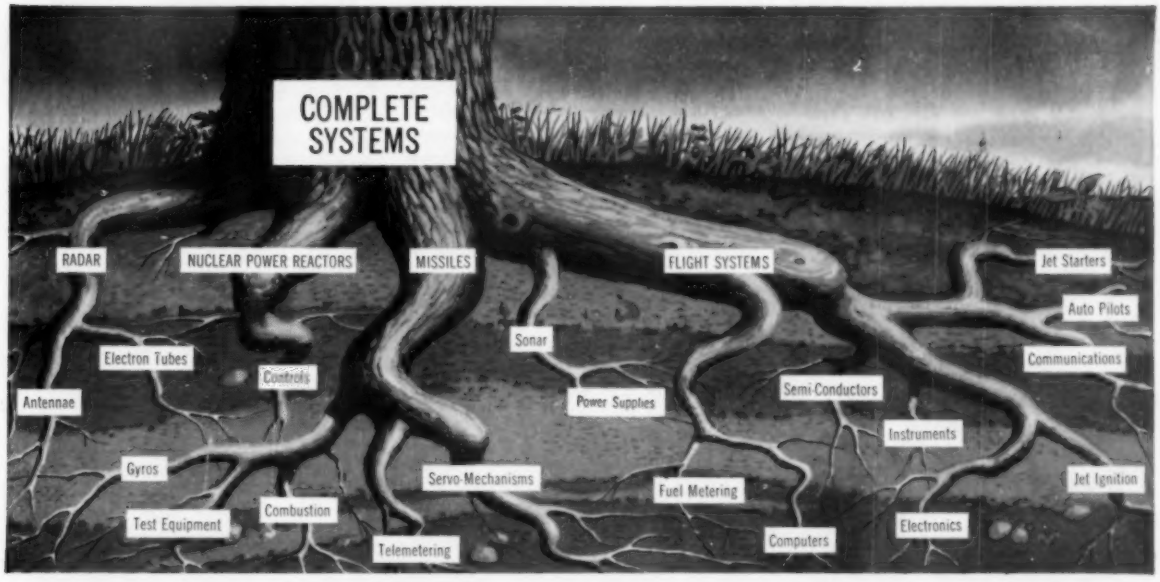

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destined to have a tremendous economic and political impact on the future. The British point of view is presented throughout.

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Thermal Power from Nuclear Reactors. By A. Stanley Thompson and Oliver Rogers. New York: John Wiley & Sons. 229 pp. $7.25.

IN this study of the application of engineering principles to nuclear designs the explanations and developments are meticulously clear and detailed, and the reader is seldom required to fill in "obvious" missing steps.

The authors open with a cogent summary of nuclear engineering concepts, then move on to treat the "reactor equations" and reactor kinetics. The treatment is clear, practical, and up to date. It is oriented to numerical approximations and machine computation. The last portion of the book treats the engineering of thermal power equipment as related to reactors. In this part, direct reference to reactors is infrequent.

This book will be a useful addition to any library on nuclear power technology. —JAMES B. EDSON.

Lincoln and the Tools of War. By Robert V. Bruce. Indianapolis: The Bobbs-Merrill Company. 368 pp. $5.

THE fact that Lincoln was interested in improving the tools of war has been noted by other authors, but the subject had never been adequately explored until now.

At the outbreak of the Civil War the Federal Ordnance Department was so busy with production problems that very little time and personnel could be devoted to weapons developments. In addition, Brig. Gen. James W. Ripley, the Chief of Army Ordnance, believed the war would be short and stubbornly fought off new designs.

On the other hand, Lincoln was anxious to utilize the North's industrial superiority in achieving an early victory, but he realized that if he did not encourage armament research and development no one would.

Lincoln reviewed a great number of innovations, some bordering on the fantastic. Others, including submarines, a self-propelled torpedo, flamethrowers, incendiary shells, and rockets were on the right track but were before their time. His greatest ordnance achievement—one which canceled out all of the many disappointments—was the introduction of breech-loading rifles into the Union Army. He backed other outstanding projects including machine guns, mortar boats, the ironclad MONITOR, and reconnaissance balloons (the first successful use of air power in America).—ROBERT J. WARFEL.

The Gun Digest Treasury: The Best from Ten Years of the Gun Digest. Edited by John T. Amber. Chicago: The Gun Digest Company. 384 pp. $3.50 (heavy paper), $5.00 (library binding).

FOR the past ten years the annual editions of this firearms compilation have satisfied the "gun hunger" of American shooters of every type. Now the "Treasury" culls the most representative articles of that period. Over fifty selections cater to every taste—as long as the taste is for guns.

Such well-known names as Haven, O'Connor, Sharpe, Engelhardt, Grancsay, and Roper are among the contributors, and several long pieces, such as "Story of European Proof Marks" and "Military Small Arms of World War II" are really significant in their fields. The "Treasury" will surely be a valued item in many a gun lover's library.—F. W. FOSTER GLEASON.

Return to Power. A Report on the New Germany. By Alistair Horne. New York: Frederick A. Praeger. 415 pp. $6.

THE recovery of West Germany after the Second World War was not a mere matter of clearing up the rubble and getting back to production tasks. The enormous and involved political difficulties are not clearly understood by most Americans, and this book should be useful for any one who wants to get a clear and fairly concise story of how a wrecked and disorganized nation was brought back to sane social and economic pathways.

By excellent handling of the problems in twenty well-written chapters the author has untangled the complex German problem and given the reader an exceptionally clear insight into how the infinite patience of a relatively few German, American, and British statesmen led West Germany out of its social, political, and economic morass into a path that not only gives promise of a better Germany, but also of a more happy way ahead for Europe. The book is easy to read, and

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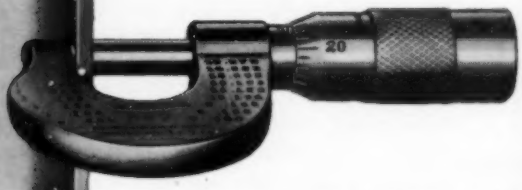

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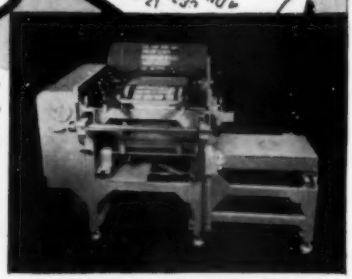

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Book Reviews (Contd.)

for perhaps the first time gives to the American reader a clear picture of what has happened and is happening in Central Europe.—GEORGE S. BRADY.

Legal Problems in Engineering. By Melvin Nord. New York: John Wiley & Sons, Inc. 391 pp. $7.50.

THIS excellent work should not only be on the reference shelf of every practicing engineer but must be added to the growing list of "very desirable" if not "required" texts of any good curriculum in engineering, especially mechanical engineering, in which a course in administrative engineering is incorporated. "It does not pretend," observe the publishers, "to make the engineer independent of lawyers, but it will help him to avoid legal problems before they arise and to work more effectively with lawyers if they do."

The work is packed with terse discussion of such matters of concern to the engineer as contracts, sales, insurance, torts, workmen's compensation and labor law, together with a clear, if brief, statement of the patent rights of employers and employees—at least one aspect of the law with which every engineer should be familiar.—ARTHUR F. MACCONOCHIE.

Welcome Aboard. By Florence Ridgely Johnson. Annapolis: U. S. Naval Institute. 269 pp. $3.50.

THIS highly informative guide to life in the Navy, written by the wife of a distinguished naval admiral, is directed especially to young Navy wives. At the same time it contains a mass of information that naval officers themselves will find useful. Legal matters, emergency help available to Navy families, and basic social customs in the service are a few of the many subjects explained in lucid style.—J. M. P. WRIGHT.

The First and the Last: The Rise and Fall of the German Fighter Forces, 1938-1945. By Adolf Galland. New York: Henry Holt & Company. 368 pp. $4.95.

ADOLF Galland, one of the younger officers of the Luftwaffe who, early in the war became "General of the Fighter Arm," gives this personal report on the rise and fall of the German Air Force during the Second World War.

He here reveals the failure of Hitler properly to evaluate the vital assistance of the fighters of the Luftwaffe in the final defense of Germany. Galland graphically and frankly tells the rôle of his fighter forces in all the major operations of World War II, including the large-scale bombing of industrial Germany by the Allied air forces. He gives both sides

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Some of TACAN's advantages over other systems include: three times greater accuracy; handles more airlane traffic—allows planes to fly *safely* at closer intervals; permits starting landing approaches further out—minimizes "stack up" of planes waiting to land; meets military requirements for ruggedness, compactness and mobility.

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TACAN REQUIRES INTEGRATED SKILLS

Range (distance) indicator
Azimuth (direction) indicator

Control Panel

Receiver
Transmitter
Strobe circuits
Reference pulse detector
Envelope signal detector
Phase comparison circuits

CLOSE TEAMWORK of research, development and production engineering

TECHNICAL ABILITY to achieve maximum component density. TACAN contains as many tubes as four TV sets (plus more than 8,000 other parts), takes up half the space of one TV set

EXPERIENCE AND FACILITIES to field test complex systems in every conceivable weather condition and environment

PRODUCTION KNOW-HOW to build a unit capable of withstanding the rigors of military operations, and the intense G-shock and vibration of carrier deck landings

INITIATIVE to develop and produce complete test equipment to make TACAN in use 100% safe and efficient

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TO PRODUCTION LINE

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Book Reviews (Contd.)

of every engagement and the problems involved.

This book will take its place with some few others as an important part of the authentic history of World War II as reported by those in positions of authority which enabled them to know all the pros and cons and to give the reader the truth as they saw it.—BURTON O. LEWIS.

BOOKS RECEIVED

Casting Techniques for Explosives and Other Nonmetallic Materials. By Thomas C. Goodwin, Jr. Edited by Mauree W. Ayton. Washington, D. C.: The Library of Congress. 50 pp. $0.45.

Conduction Heat Transfer. By P. J. Schneider. Cambridge, Mass.: Addison-Wesley Publishing Company. 395 pp. $10.50.

Modern Physics, Textbook for Engineers. By Robert L. Sproull. New York: John Wiley & Sons, Inc. 491 pp. $7.75.

Police Drugs. By Jean Rolin. New York: Philosophical Library. 168 pp. $0.75.

Powder Metallurgy—Now (New Techniques, Improved Properties, Wider Use). By F. V. Lenel. H. W. Gillett Memorial Lecture, 1955. Philadelphia: American Society for Testing Materials. 34 pp. $1.50.

Report on Unidentified Flying Objects. By Edward J. Ruppelt. New York: Doubleday & Company. 315 pp. $4.50.

Risks: The Key to Combat Intelligence. By Col. Elias Carter Townsend. Harrisburg, Pa.: Military Service Publishing Company. 82 pp. $1.

Specifications and Tests for Electrodeposited Metallic Coatings. Prepared by ASTM Committee B-8 on Electrodeposited Metallic Coatings. Philadelphia: American Society for Testing Materials. 104 pp. $1.85.

Spy Stories from Asia. By Kurt Singer. New York: Wilfred Funk, Inc. 336 pp. $3.95.

Story of Standards. By John Perry. New York: Funk & Wagnalls Company. 271 pp. $5.

Theory and Technique of Ship Design. By George C. Manning. New York: John Wiley & Sons, Inc. 278 pp. $10.

Thermodynamics. By John Francis Lee and Francis Weston Sears. Cambridge Mass.: Addison-Wesley Publishing Company. 543 pp. $8.50.

Tungsten: The Story of an Indispensable Metal. By Mildred Gwin Andrews. Washington, D. C.: The Tungsten Institute. 28 pp. NP.

U. S. Marine Operations in Korea. Vol. II. By Lynn Montross and Capt. Nicholas A. Canzona, U.S.M.C. Washington: U. S. Government Printing Office. 361 pp. $2.50.

NEW Silicone Compound

DOW CORNING 6, a new grease-like silicone compound, is the ideal lubricant for threads on bombs, shells and rockets. A thin film of this silicone lubricant keeps threads working freely even after long exposure to corrosive atmospheres and temperatures ranging from 65 F below zero to 400 F.

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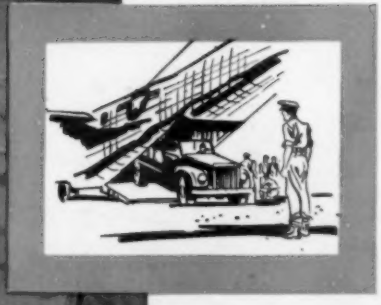

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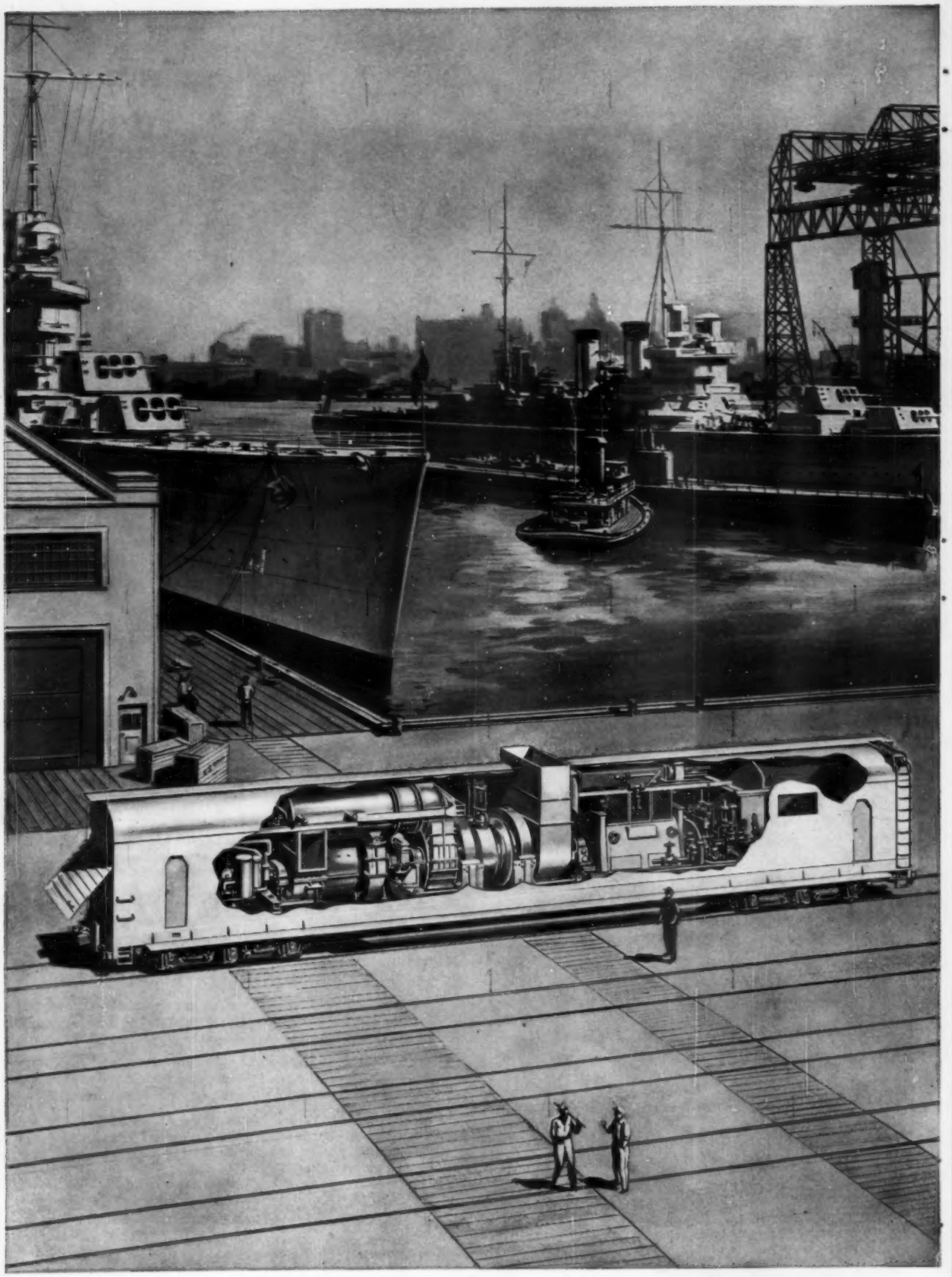

Clark Bros. Co. puts

5,500,000 watts on wheels

Completely self-contained on one railroad car and capable of safe travel at any train speed, this turbo-mobile power plant will deliver 5,500 KW within hours after reaching site where emergency power is needed. Conceived by the Bureau of Yards and Docks of the United States Navy, such a project had never been faced before and set up staggering problems of design and construction. Original specifications called for a minimum of 4,500 KW, but Clark Bros. Co., beat that by 25%, with additional overload capacity. The completely new type of gas turbine drive can use almost any available liquid or gaseous fuel. A one-man crew can operate it.

The ability of Clark Bros. Co., one of the Dresser Industries, to design and build this revolutionary new power plant springs from its 75 years of specialized manufacturing experience. "Precision by the ton" is literally true of Clark engines, compressors and turbines serving the world's basic energy industries.

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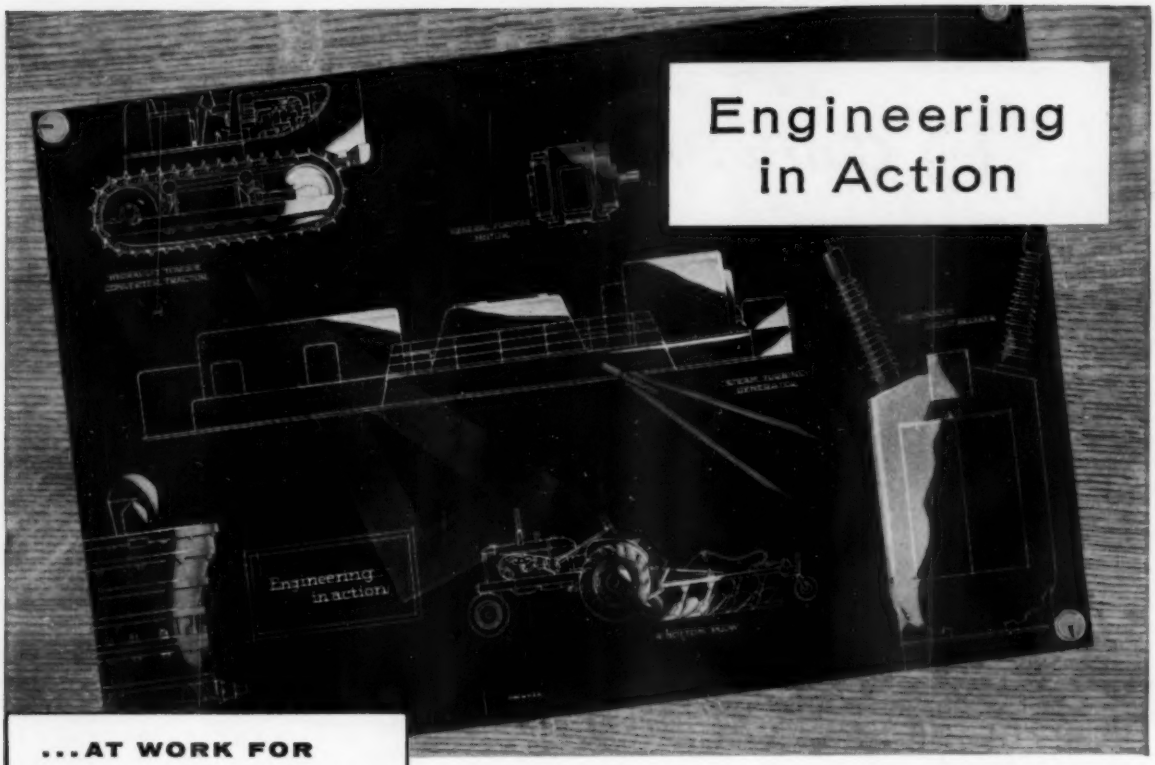

...AT WORK FOR THE ARMED FORCES

Engineering in Action is a creative approach that reaches out into many fields of engineering for new principles and new ways to apply them . . . for better performance, lower cost and longer life.

Engineering in Action starts with a way of thinking—in laboratory research, field testing and manufacturing methods. It makes the name "Allis-Chalmers" a symbol of better living and better things to come.—ALLIS-CHALMERS—GENERAL OFFICES—MILWAUKEE 1, WISCONSIN

Ontos (Greek for "the thing"), a new highly mobile, anti-tank weapon, mounts six 106 mm recoilless rifles, four .50-caliber spotting rifles and one .30-caliber machine gun . . . goes into production at Allis-Chalmers this year.

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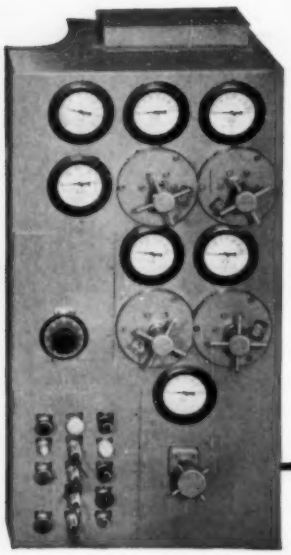

...the only press that can do so many things so well

THIS hydraulic press revolutionizes the high speed production of draw-formed parts. We believe that it has rendered obsolete every double-acting and triple-acting press now in service. These are challenging statements... *but read the facts.*

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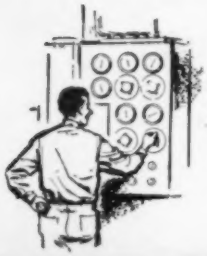
- **Unlimited speed changes** now possible at any point in the cycle. This means, for example, that the ram can approach the draw at maximum speed, slow down as it enters the draw, change speed in the middle of the draw, strip slowly and return to up position at maximum speed.
- **Draw-forming of difficult materials** is thereby greatly simplified and improved. The exact speed can be selected which is best suited to the characteristics of the material at any point in the stroke.
- **Expensive dies** can be given added protection by "gentle" treatment at point of contact and withdrawal.
- **Cycle time is greatly reduced,** because maximum speeds can be attained at every desired point in the cycle.
- **No expensive cams** with time-consuming adjustments are needed to obtain these results. All speed changes are made by dial settings on the control panel.



- **4-point adjustment of blank holder pressure** is made by operator without leaving operating station, an important device in the draw-forming of eccentric shapes. This has been a feature of Farquhar Double-Acting Presses in the past. It is an important feature of the new Farquhar Double and Triple-Acting Presses, too.
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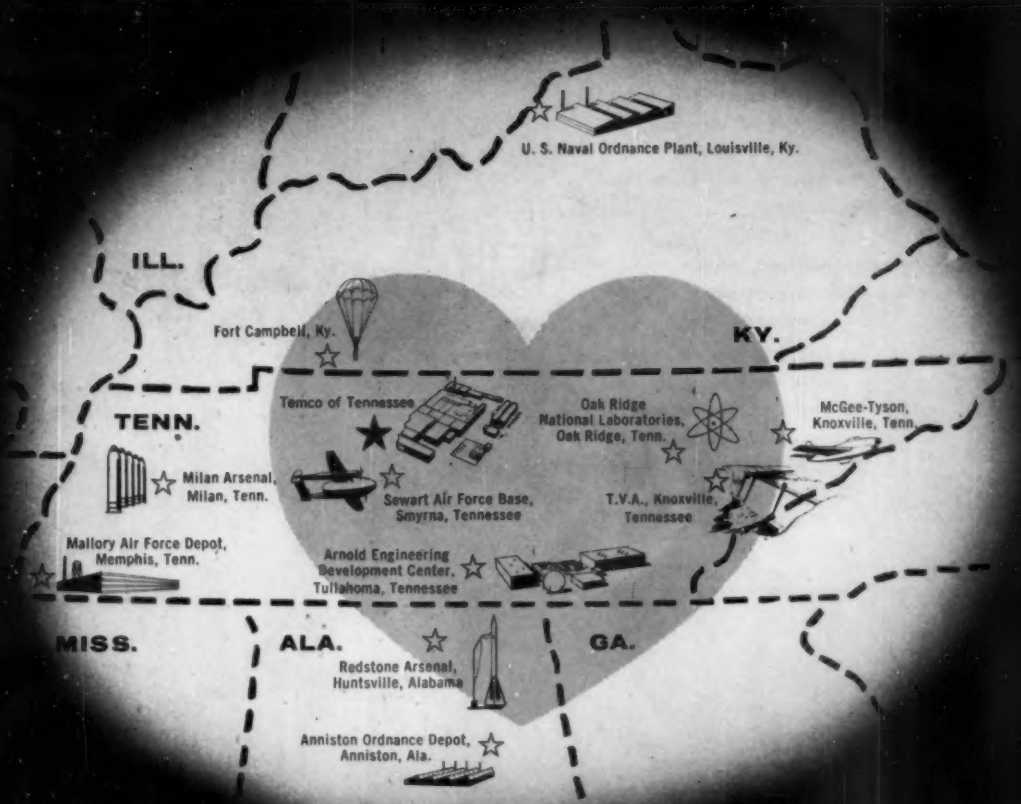

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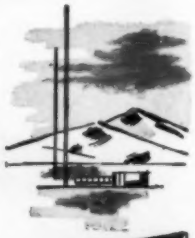

When planning a radio communication system, consult Collins for assistance in all phases of the engineering. Technical literature is available for the over-all design and individual equipment.

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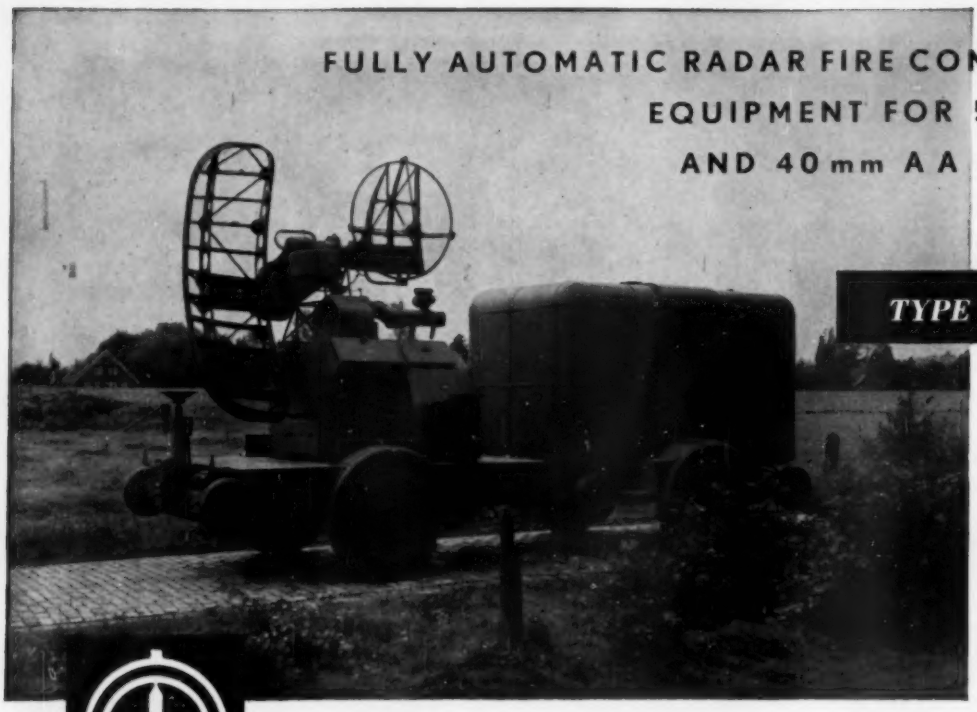

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3. An Alumilite 225 hard anodic finish is used which gives a case hardening to the aluminum surface. This finish offers outstanding resistance to corrosion and abrasion.
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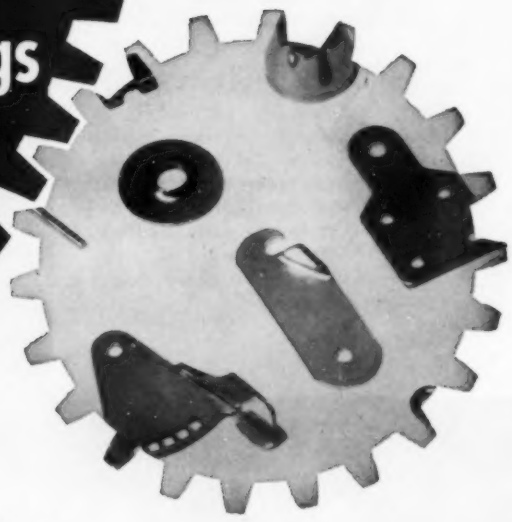

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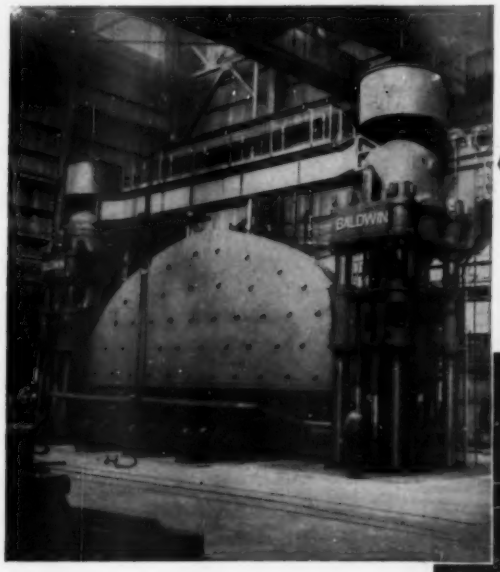

This huge, 8000-ton hydraulic beam press easily performs bending and forming operations on steel plates up to 9 inches thick and 39 feet in length.

Here, on one of the largest double housing planers in the country, welding grooves are machined in one half of a cylinder for a large pressure vessel.

Twin arc automatic submerged arc welder joins two longitudinal half shells for a 6-inch thick pressure vessel.

With four large and exceptionally well equipped plants — at Carteret, N.J., Mountaintop, Pa., Dansville, N.Y. and St. Catharines, Ontario — Foster Wheeler offers a unique fabricating service to industry. High-pressure vessels, heavy-wall pipe and unusual weldments to Code requirements and beyond, as well as your lighter fabrications, can be produced by the most modern and efficient methods, with substantial savings in time and cost.

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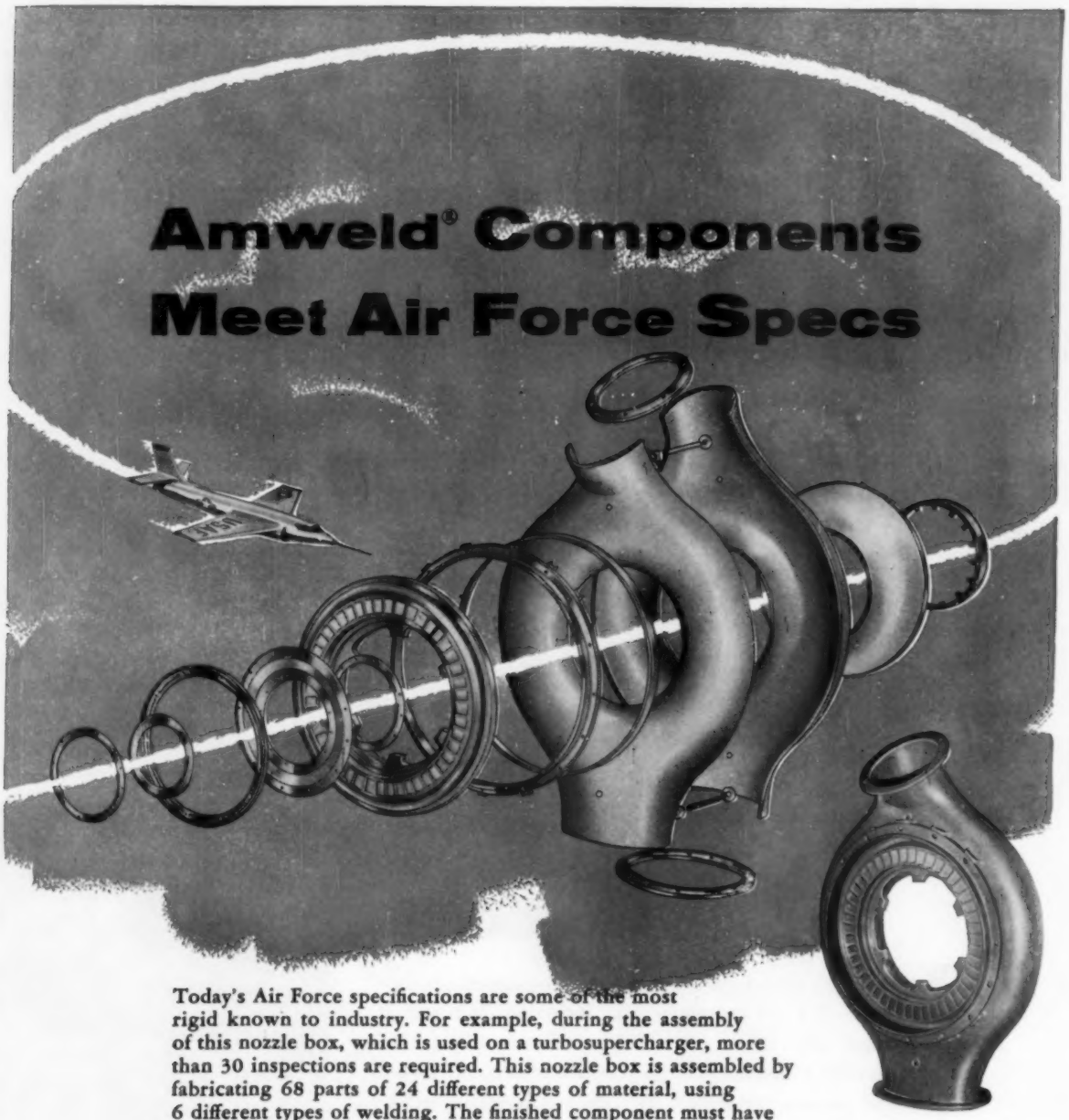
Amweld® Components Meet Air Force Specs



Today's Air Force specifications are some of the most rigid known to industry. For example, during the assembly of this nozzle box, which is used on a turbosupercharger, more than 30 inspections are required. This nozzle box is assembled by fabricating 68 parts of 24 different types of material, using 6 different types of welding. The finished component must have the same tensile strength and original characteristics as the parent metal.

Amweld, with its special ability to form, weld, size and machine rings, circular weldments and components, is geared to the manufacture of such complex parts.

Do you have a component assembly problem? If so, contact the Industrial Products Division of The American Welding & Manufacturing Co. today! They will be pleased to help you.

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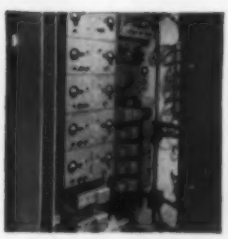
Transportable 800 lb. Magnesium antenna mast telescopes to 100 ft. Trained crew of 8 men can erect mast in less than an hour.

Microwave System capabilities include the transmission of voice communications (up to 72 two-way channels), radar data and radar control functions.



Transportable Packages Grow into Miles of Communications in 2 Hours

A microwave station that can be transported to a site by helicopter and then put into operation in as little as two hours has been developed by Motorola for the U.S. Air Force. The equipment was designed to satisfy Air Force requirements for high information handling capacity, transportability, and quick installation.

Positions open for Engineers and Physicists.

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National Defense Department

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USS JOHN PAUL JONES (DD932) — potent addition to the Navy's Destroyer Force, was built by the Bath Iron Works, Bath, Me.

Navy's New John Paul Jones Depends on

G-E FIELD SUPERVISOR and Navy specialist at main battery fire control switchboard. General Electric provides field service on all its ordnance equipment.

RADAR-DIRECTED G-E MARK 56 GUN FIRE CONTROL SYSTEM provides semi-automatic antiaircraft defense fore and aft on the USS John Paul Jones.

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G.E.'S RUGGED AMPLIDYNE POWER DRIVES provide accurate elevation and train for the USS John Paul Jones' fore and aft 3"/50 batteries.

General Electric ordnance equipment has been selected to assist the USS John Paul Jones in the defense of American shores. DD932 is the Navy's newest addition to its Destroyer Force.

G.E.'s famous Mark 56 gun fire control system and rugged power drives protect the USS John Paul Jones fore and aft against air attack, while G-E controls help speed acquisition of surface targets. Below decks, G-E fire control switchboards co-ordinate all topside batteries. Target designation and underwater battery switchboards complete General Electric's ordnance contribution to the USS John Paul Jones.

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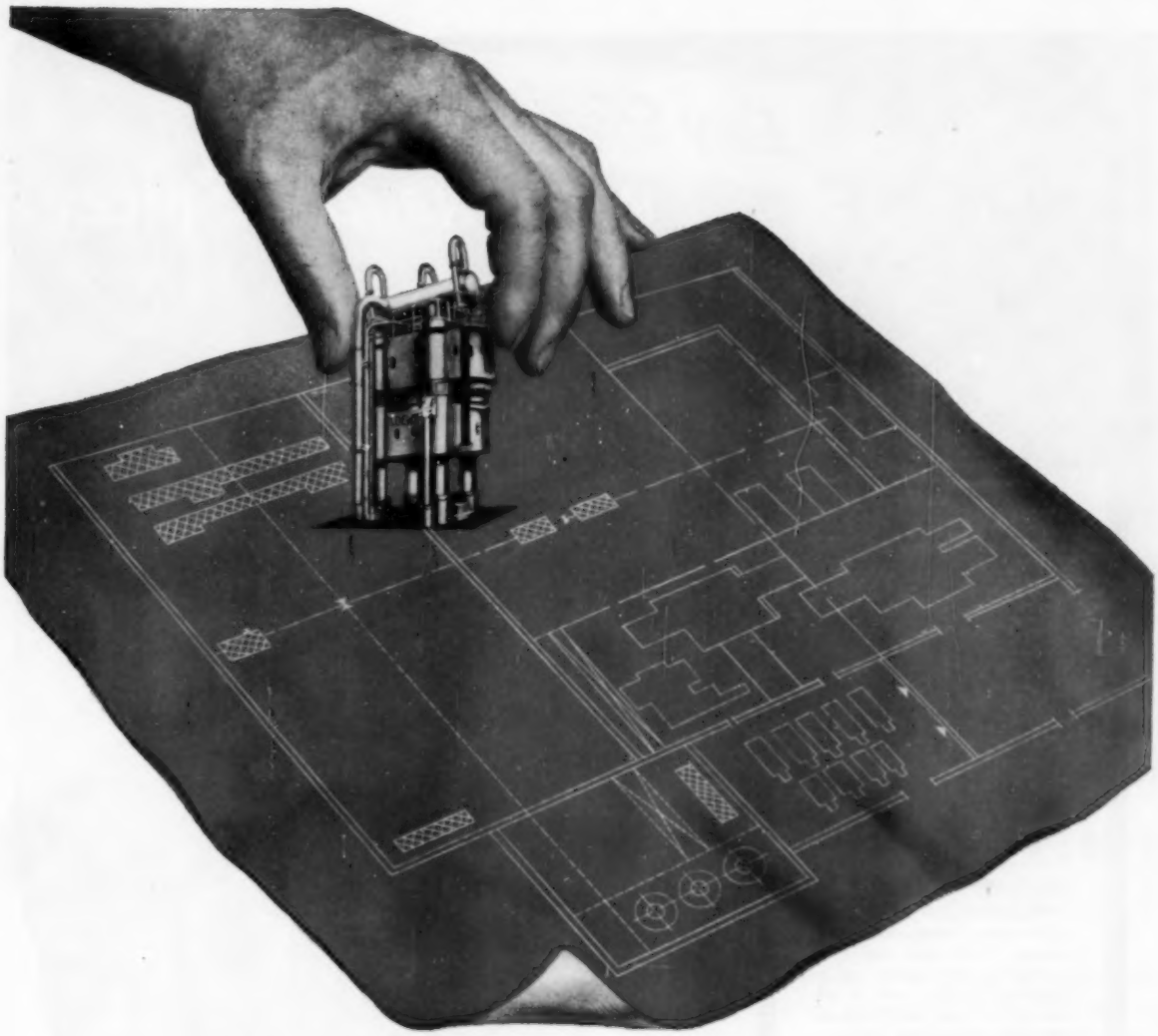

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AIR ASSIST SHIFT

An exclusive feature of the Spicer Synchronized Transmission

Advantages of Air-Assist Control with Spicer Synchronized Transmission

1. No change in shifting pattern. Operator goes through motions—air does the work . . . quickly, easily, quietly.

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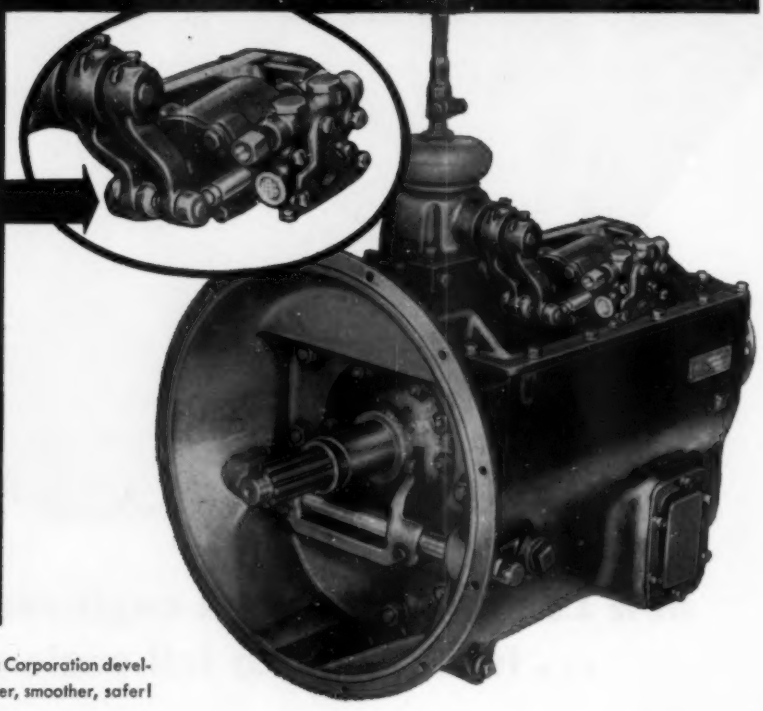
3. Permits more latitude in design of shift lever to avoid cab interference. The long lever required for proper hand leverage to shift synchronized transmission not required when Air Assist is used.

4. Easily adaptable to any Spicer Synchronized Transmission, as substitution of shift tower only is required. Air Assist cylinder can be assembled at either side of shift lever and air hose connection available at both ends of air cylinder.

5. Only one outside air hose required.



The new Spicer AIR-ASSIST Shift is another Dana Corporation development to make truck and bus operation easier, smoother, safer!

The AIR-ASSIST Shift is available only on Spicer Synchronized Transmissions . . . optional on new equipment, or available as a replacement unit on Spicer Synchronized Transmissions now in use.

The AIR-ASSIST Shift adds another feature to the long list of advantages already offered by the Spicer Synchronized Transmission:

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- **Alloy Steel Carburized Gears**
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- **Gear Hopping Guards**
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Over 250,000 Spicer Synchronized Transmissions have been installed in heavy-duty trucks and busses, for a wide range of civilian and military services. Ask Spicer engineers to help you adapt the Spicer Synchronized Transmission and the new AIR-ASSIST Shift to your needs.

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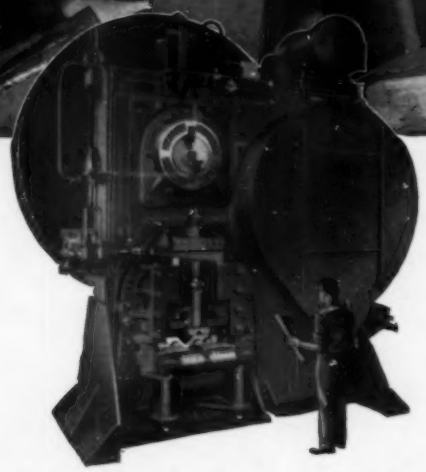

No. 17 Billet Shear. Capacity, 10" rounds or 9" squares, 6 strokes per minute.

a "Buffalo" billet shear did it all in 10 minutes!

You're looking at a hundred 7" square billets readied for forging in just ten minutes by a "Buffalo" No. 15 Billet Shear with automatic feed table and back gage. This is just a sample of the high output of "Buffalo" Billet Shears in the nation's leading shops.

And note the clean, square faces of each cut. There's no smearing to conceal porosity, as with burning or sawing. The shear penetrates only 3/16", localizing a neat, accurate vertical fracture. Divisions are uniform in dimensions and weight. Your quality keeps up with your speed!

Write for Bulletin 3295-C for all details.

"Buffalo" Billet Shears are built in 11 sizes to handle *your* size rounds, squares or flats. The smallest one shears thirty 2¼" rounds per minute; the largest, six 10" rounds per minute. Rigid arc-welded steel plate frames —"power" lubrication—air operated clutches, counterbalance and hold-down—are some of the "Q" Factors* that assure you years of service with practically no maintenance.

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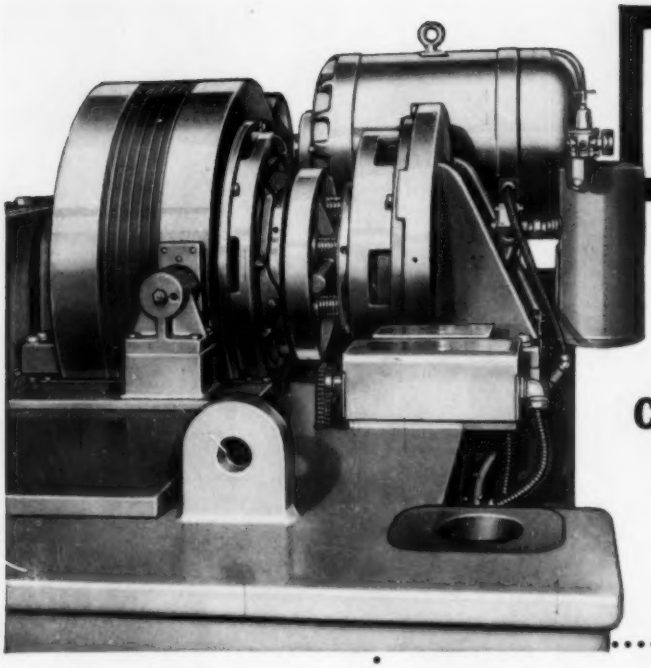


These are the features **that make -Verson- presses your best buy**

THE -Verson- CLUTCH AND BRAKE UNIT

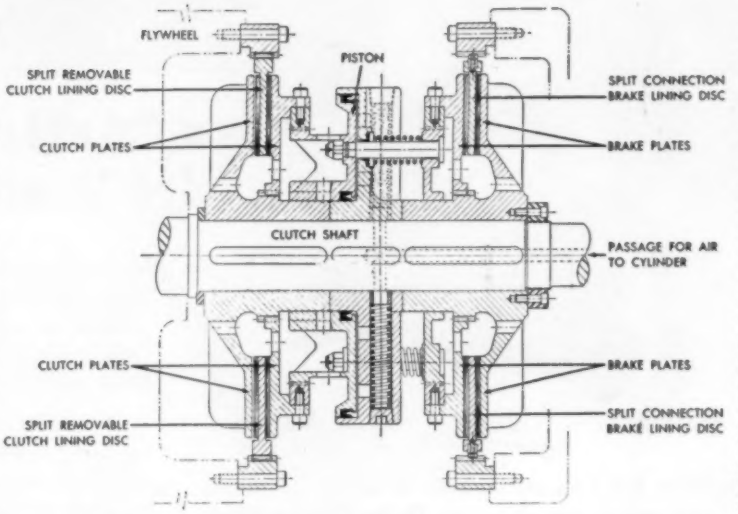
No tricks— just top notch performance

The drawing at the right shows the construction and operation of the Verson clutch and brake unit.

With the clutch disengaged, powerful brake springs clamp brake plates against the stationary brake disc. The brake disc is mounted to the press frame in a manner that will permit axial motion but will oppose rotation.

To engage the clutch, air is admitted to the operating cylinder through a passage in the drive shaft. This forces the piston out, compressing the brake springs and releasing the brake. Further motion of the piston engages the clutch thereby transmitting the motion of the flywheel to the clutch shaft.

When air pressure in the operating cylinder is released, the brake springs pull the piston back, first disengaging the clutch and then engaging the brake.



The Verson Pneumatic Clutch and Brake Unit is the heart of Verson mechanical presses. It is a mechanically interlocked type which eliminates all possibility of overlap between clutch and brake. Drag cannot occur, efficient power application is assured and wear on clutch and brake linings is minimized. Shock and vibration are also minimized for longer press life. This is no trick clutch . . . it is a soundly designed unit that has been proved in countless hours of abusive tests and years of field experience.

The Verson Pneumatic Clutch and Brake Unit is just one of many reasons why it pays to specify Verson Presses for your requirements. We'll be happy to tell you the whole story. For specific recommendations, send an outline of your requirements.

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Design requirements for this testing instrument case were strength, durability, portability and low-cost production. The answer? Make it in one deep-draw from magnesium sheet—lightest of the structural metals!

When your design requirements call for a product that's easy to move and a metal that's easy to fabricate, specify magnesium. It has the right combination of lightness, strength and rigidity—and it poses no production problems in drawing, welding or machining. Start now to put this versatile metal to work for you. Call your nearest Dow Sales Office or write THE DOW CHEMICAL COMPANY, Magnesium Sales Department, MA 357H, Midland, Michigan, for further information.

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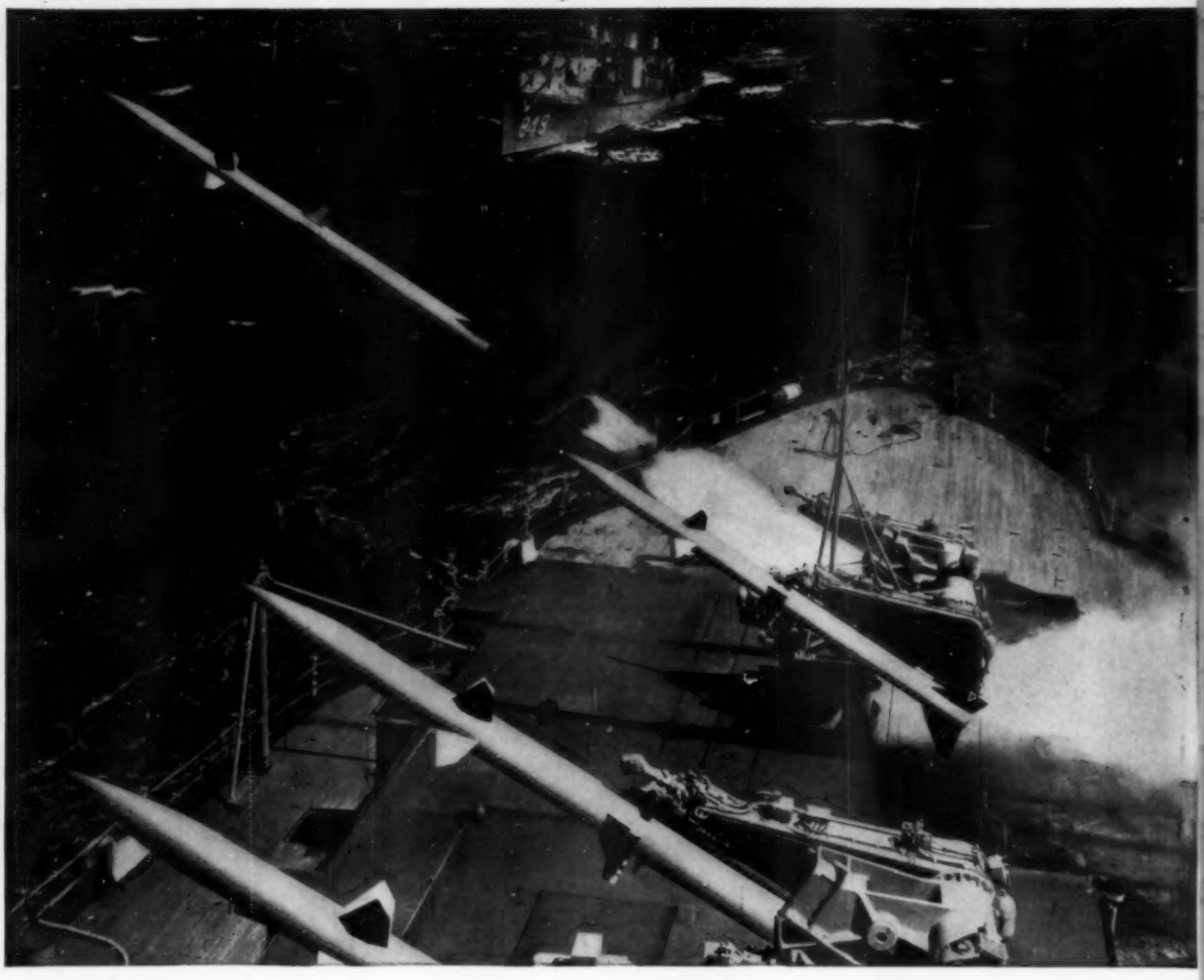
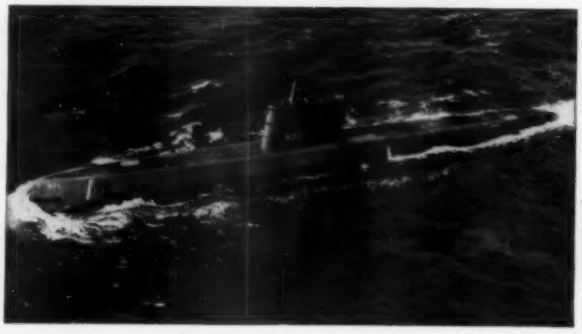


CURRENT PRIME CONTRACTOR FOR ARMY'S M48A2 TANK, ALCO calls on products of some 1500 subcontractors for assembly. M48's will be built in facilities which produced thousands of M47's during Korea, will receive benefit of know-how drawn from almost 10,000 ALCO-built tank vehicles.

HEAT EXCHANGERS FOR ATOMIC SUBMARINE were built by ALCO. The Nautilus has radical-design ALCO exchangers in its reactor system. Design, to solve advanced heat-transfer problems, and facilities for difficult manufacture were provided by ALCO.



key items for defense

Important Components from ALCO are Installed in Leading Weapons of All Three Services; ALCO also Serves as Prime Contractor

ALCO-built weapons components range from heavy final drives for tanks to air flasks and propellant chambers for missiles, to complicated and precise recoil mechanisms. For the M48A2 medium tank, ALCO also serves as prime contractor, doing complete assembly of items from 1500 suppliers.

Long experience in defense production, beginning in 1860, is one reason why ALCO is successful in helping make modern weapons. Its products have included guns, shell casings, locomotives and marine diesels, among others. During World War II and Korea, ALCO made thousands of combat tanks.

Production and design facilities are another important reason for ALCO leadership. Its plants are equipped to assemble heavy defense items in large quantities, and also to produce highly complicated components for other prime contractors. ALCO's design engineering staff is expert in specialized fields such as atomics and weapons development.

ALCO production available for defense purposes includes heavy weldments, heat-transfer items, pressure containers and vessels, springs, forgings, rings, precision-machined items, diesel and atomic power, and all types of assembly, including electronics.

Consider ALCO for new defense items. Seven plants in five states. Complete facilities. Advanced engineering. Write P.O. Box 1065, Schenectady 1, N. Y. for more complete information.

"TERRIER," NAVY'S SURFACE-TO-AIR GUIDED MISSILE, incorporates ALCO-built air flask to operate complicated servo control system. Jato boosters for the Air Force's Snark missile and the Army's Honest John are other ALCO products.

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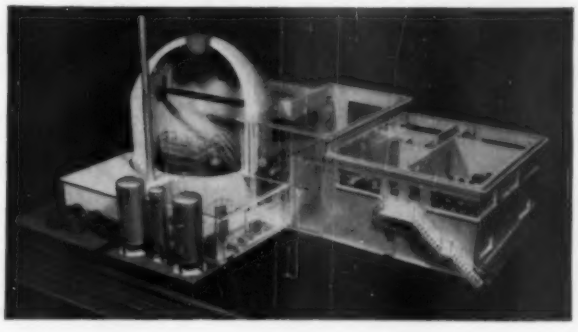
RECOIL MECHANISM FOR ARMY'S 155 MM HOWITZER, a precision-manufactured complex of springs and hydraulic units, was manufactured by ALCO as prime contractor. Army Ordnance called ALCO production of this item "in the highest quality group received from industry."

ARMY PACKAGE POWER REACTOR, not a weapon, will generate power at Fort Belvoir, Va. Future APPR's will power remote installations. ALCO holds prime contract for unit, won in competition with 17 top U. S. manufacturers. APPR will be erected by ALCO by early 1957.



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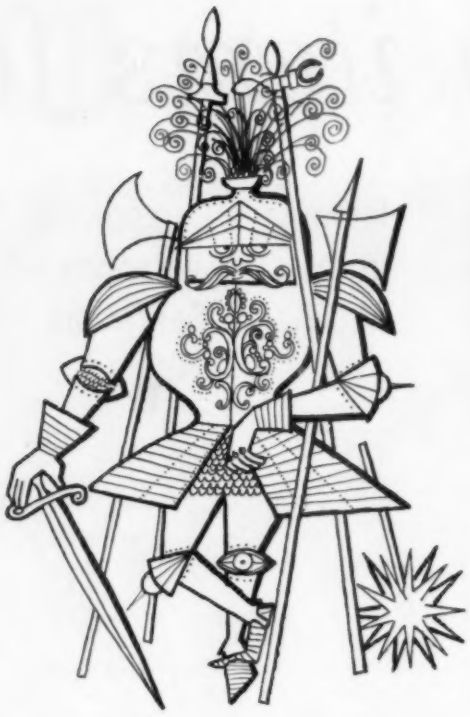

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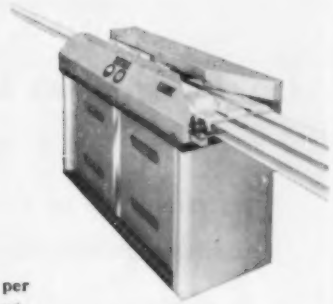

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VOLUME XL

● The Index to Volume XL of ORDNANCE, with title page for binding, is now available. It will be sent free of charge upon request to the Editorial Offices at the address below.

● It covers subjects in the following 1955 and 1956 issues: July-August (No. 211); September-October (No. 212); November-December (No. 213); January-February (No. 214); March-April (No. 215); and May-June (No. 216). It is arranged alphabetically by subject and author.

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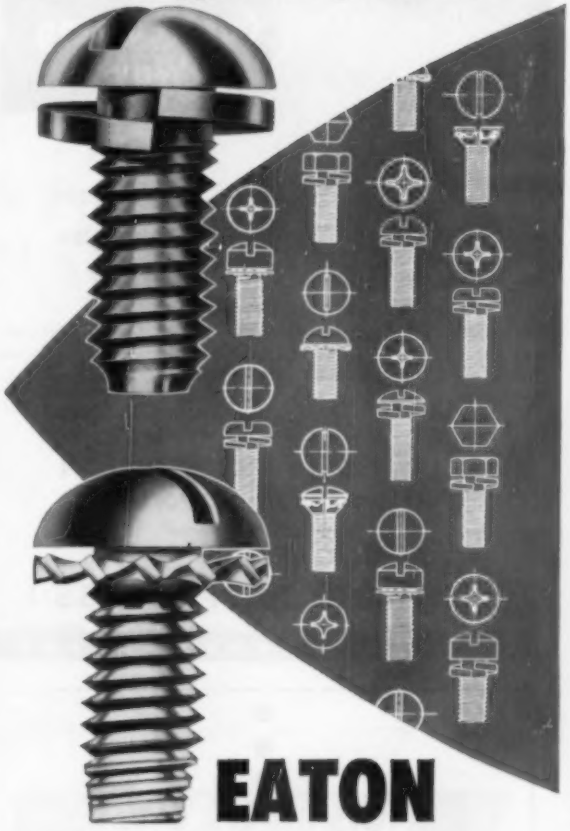

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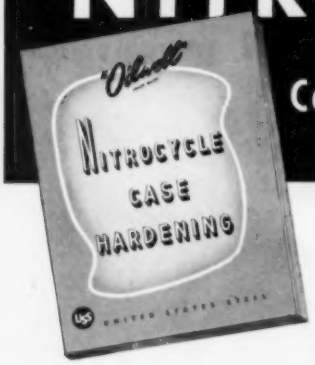

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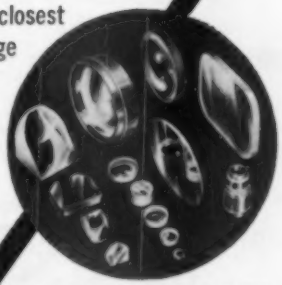

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ARMAMENT TECHNOLOGY

This section of ORDNANCE contains selected papers presented at meetings of Technical Divisions and Committees of the American Ordnance Association and contemporary articles on armament research, development, manufacture, and field use

Ultrasonic Detective

New device plots flaws in thick armor castings with speed and accuracy

C. H. Hastings and Sgt. R. W. Buchanan

Mr. Hastings is the chief of the nondestructive testing section, Watertown Arsenal, Watertown, Mass. Sergeant Buchanan is a former project engineer at Watertown Arsenal. He is now with the Denver Research Institute, Denver, Colo.

INTENSIVE investigations of ultrasonic testing techniques and principles have been under way at Watertown Arsenal Laboratories for approximately ten years since the introduction of the pulsed-echo technique by Dr. F. A. Firestone.

The studies involved have been focused on potential Ordnance applicability of these techniques as a means for solving inspection problems and as a means for providing more reliable, rapid, and economical techniques and equipment for the evaluation of Ordnance matériel.

As a result of these investigations it was concluded that ultrasonic flaw testing as practiced during the last 10-year period was severely limited for Ordnance application for two reasons:

FIRST, ultrasonic energy was introduced into metals to be examined by placing a quartz crystal transducer directly in contact with the metal surface, employing as an acoustic coupling a film of oil.

Because of the intimate contact required between the crystal transducer and the surface of the material, only reasonably smooth surfaces could be tested, and hence a large proportion of Ordnance inspection could not be performed. This may be referred to as the "rough-surface problem."

Secondly, the results of ultrasonic flaw tests were presented on a cathode-ray oscilloscope screen in such a form that extensive training and experience on the part of the test equipment operator were required for intelligent interpretation of test results.

Actually it was felt that, for proper utilization of existing ultrasonic equipment on Ordnance problems, the inspector or test equipment operator must have considerable knowledge of electronics, acoustics, and metallurgy. Since this situation appeared to be associated primarily with the interpretation of the cathode-ray presentation of ultrasonic echoes, it was referred to as the "data-presentation problem."

IN spite of the above limitations of ultrasonic flaw-detection techniques, it was felt that they offered potent advantages which might be realizable for Ordnance testing problems through developmental work devoted to overcoming or minimizing the limitations.

The advantages might be enumerated briefly as (1) relatively low equipment cost; (2) virtually no installation expense; (3) test data obtained extremely rapidly; (4) little, if any, limitations on thickness of material which can be examined; (5) adjustable sensi-

CONTENTS

ARMAMENT TECHNOLOGY SECTION

Ultrasonic Detective 167
C. H. Hastings, Sgt. R. W. Buchanan
New flaw-plotting device

Development of Air Power .. 169
Col. W. L. McCulla, U.S.A.F.
Achievements of the AEDC

New TNT Loading Method 174
Col. O. M. Jank
Value of using flaked explosive

Automotive Gas Turbines .. 177
2nd Lieut. R. L. Curl
Possible new power source

tivity or test severity; and (6) extremely high flaw sensitivity available when required.

A comparison of the above advantages with other methods for testing Ordnance materials strongly emphasizes the advisability of developmental work to make this test available for Ordnance use. For example, magnetic tests are severely limited in their ability to detect deep-seated flaws.

Radiography, the only other reliable method for subsurface flaw detection, is severely limited in its depth of penetration, requiring extremely expensive equipment and installation to penetrate steel thicknesses greater than three or four inches. Even when such radiographic equipment is available the severity of test cannot be readily adjusted, the test is time-consuming, and maximum sensitivity attainable is low compared with ultrasonic techniques.

WHILE there is no thought involved here that ultrasonic testing can or will make radiography obsolete for Ordnance testing and inspection, it has been felt for some time that there are a sufficient number of Ordnance testing problems which can be better solved by ultrasonics than by radiography to warrant a considerable expenditure of effort in this direction. It is the purpose of the following discussion to indicate the progress which has been made as a result of such effort.

In February 1951, Electro Circuits, Inc., Pasadena, Calif., proposed means for overcoming the two limitations cited above, namely: the "rough-surface problem" and the "data-presentation problem." Watertown Arsenal Laboratories accepted the Electro Circuits proposal, which resulted in the delivery of ultrasonic flaw-plotting equipment, the "breadboard model" of which has been given extensive evaluation study to determine its applicability to Ordnance inspection problems.

INITIAL attention is being devoted to the applicability of such apparatus to the examination of thick armor castings, for which testing problem this equipment is felt to be uniquely advantageous.

It should be repeated that metal thickness is basically no problem for ultrasonic testing. The flaw-plotting equipment is designed to function on thicknesses from one-half to six inches. The upper thickness limit can readily be increased by slight design modification. The problem of examining materials having rough and as-cast surfaces has been overcome by mounting the quartz transducer crystal in a nozzle 1½ inches from the material being inspected and coupling the crystal acoustically to the specimen with a water stream.

The data-presentation problem has been solved by employing two pictorial or flaw-image displays. In the past, ultrasonic information has been presented on an "A-scope." The Watertown equipment is capable of a much cleaner A-scope presentation than prior equipment due to advanced design of the electronic receiver and advanced concepts of crystal transducer operation.

These improvements permit the detection of flaws much closer to the front surface of a casting than previously possible and also the individual detection of multiple flaws lying close together in the thickness of the specimen. These represent major improvements over previous equipment and techniques.

In addition, the Watertown equipment provides a pictorial cross-section view of the interior of castings being examined which permits the location of a flaw in the depth dimension relative to the front surface of the test specimen and a plan view which provides information regarding the area and shape of the flaw in a plane parallel to the inspection surface.

It has been felt that the ability of the radiographic method to present flaw images by which the size and shape of flaw can be employed as a means for distinguishing between one type of flaw and another is of tremendous advantage for the examination and acceptance testing of cast armor.

Based on this thinking the advantage of pictorial ultrasonic flaw images can be readily appreciated both from a point of view of flaw recognition and ease of inspector training. Of course, the additional information regarding depth of flaw below surface is readily obtainable from the ultrasonic equipment.

Inspector makes third-dimensional study of industrial radiograph. Before ultrasonic technique, radiography was the only good subsurface flaw-detection method.

WHILE the apparatus presently being studied is a "breadboard model" of the ultrasonic flaw-plotting equipment, the advantages originally sought in connection with its development have been dramatically illustrated through its early use. It is anticipated that a continuation of this development will result in the procurement of production prototype equipment for the examination of thick armor castings.

It is expected that many types of thick armor castings can be examined in approximately a twentieth of the time and with about one-tenth the cost of previously employed facilities.

Development of Air Power

The massive wind tunnels and other testing equipment at the Arnold Engineering Development Center are of inestimable value in designing and building superior aircraft, propulsion systems, and guided missiles

Col. William L. McCulla, U.S.A.F.

Colonel McCulla is special assistant to the Commander, Arnold Engineering Development Center, Air Research and Development Command, Tullahoma, Tenn.

ARNOLD Engineering Development Center (AEDC), one of the Centers of the Air Force's Research and Development Command, is located in the midst of a 40,000-acre reservation in the Tennessee hills about halfway between Nashville and Chattanooga.

This vicinity has been the location of forts and training grounds for a long time. Part of the present reservation was the site of Camp Forrest during World War II and Camp Peay during the interim between World War I and II. Almost a century ago, General Nate Forrest's Confederate troops were encamped near by.

Some claim that several centuries before, visitors of the pre-Columbus day constructed a stone fort at the confluence of the Big and Little Duck Rivers where one of the South's powder mills was located in the early 1860's.

Within a few miles of this present-day giant of air research and testing can be found the earthworks and evidences of skirmishes of a century ago as well as the early maneuvers of Patton's armored force of the past decade or two. Let us hope that the results of the research and development conducted here will help ensure that such wartime skirmishes and maneuvers are a thing of the past.

AEDC is a tremendously important asset of the Air Force and of the United States. Words alone, or even words supplemented by photographs, are inadequate to describe what is involved in this $250 million activity. It takes personal contact to give this understanding.

In that respect it resembles its namesake, Gen. H. H. (Hap) Arnold—for who can have a real understanding of this man based only on words, photographs, and tabulations of his accomplishments and abilities?

The Center carries the name "Arnold" proudly and appropriately for its inception was due in a large measure to the foresight, vision, and positive action of General Arnold, ably assisted by Dr. Theodore von Karman, Dr. Frank L. Wattendorf, and many others.

Their efforts have resulted in the design of a research and testing center of tremendous capability, versatility, and of inestimable value to our country in designing and building superior air weapons systems which, of course, include guided and ballistic missiles.

Arnold Engineering Development Center is specifically charged with planning, constructing, and operating its facilities as a service to industry, educational institutions, and agencies of the Federal Government for the development and evaluation of aircraft, propulsion systems, and guided missiles and to advance knowledge in the fields of aëronautical and propulsion test facility design and testing techniques.

In this critical period of our aviation development, saving time is of paramount importance—and that is exactly what AEDC was designed to do. Important, too, is the fact that it saves lives and money as well.

THIS may all sound very prosaic but when we take a closer look—not only at the immensity of the program which has been in the actual building stage since 1950 and for which some presently approved units are not scheduled for completion until late 1959, but also at the immensity of the equipment used and the tremendous amount of power and water necessary to run tests of only a few moments' duration—we begin to realize that this is far from a prosaic, run-of-the-mill testing installation.

A 5,000-acre reservoir, built especially for the Center's needs, provides the cooling water which the two pumping plants can circulate at the rate of 200,000 gallons a minute. (This is roughly comparable to the requirements of Washington, D. C.) The TVA System provides the tremendous amounts of electrical energy used now. Another circuit is being installed to cover currently programmed increases.

It is hard to visualize the quantities of power used and even more difficult to visualize the size of the motors which use it. Those who have been

around a steel mill know that a 2,500-horsepower motor is a pretty good sized piece of equipment. At AEDC there are 10 of these which are used to start the 10 large synchronous motors which vary from 12,500 to 36,000 horsepower.

There are two 25,000-horsepower wound-rotor induction motors which start and operate with the two 83,000-horsepower synchronous motors used to drive the world's largest rotating machinery. The shaft, with the four motors in the center, has the 3-stage transsonic compressor on one end and the 18-stage supersonic compressor on the other.

IT is as long as the Washington Monument is tall and spins at 600 revolutions per minute. That means that the tips of the 1,200-pound, 6-foot-long blades of the transsonic compressor which are fixed to a disk 18 feet in diameter are approaching the speed of sound. Its inertial energy is 84,000,000 pound-feet squared.

Fundamentally, the technical part of the Center is composed of three basic units: the Engine Test Facility with its Ramjet Addition, the Gas Dynamics Facility, and the Propulsion Wind Tunnel with its transsonic and supersonic branches.

These facilities make it possible to study, under carefully controlled conditions, full-size jet engines operating at full power under simulated flight conditions of sub-, trans-, and supersonic speeds and at altitudes varying from sea level to ones in excess of 80,000 feet (each speed range is not necessarily available at each altitude), and at temperatures varying from 120 degrees to substantially above 650 degrees Fahrenheit.

Aërodynamic models can be studied under an even wider range of speed and altitude with Reynolds numbers which are high enough to ensure excellent correlation with subsequent flight tests of the full-scale article.

In the Propulsion Wind Tunnel the jet engine which has been tested and developed in the Engine Test Facility can be incorporated in the missile, nacelle, or wing section which was based on the model tested in the tunnels of the Gas Dynamics Facility and the whole unit flown under power to determine its actual performance.

This is the way that the development cycle of new power plants, airplanes, and missiles is being compressed. It means new weapons systems go into production and into operational units at an earlier date.

By finding out on the ground in a period of days and weeks the safe operating conditions, the performance characteristics, and the limitations of these systems and components, not only have we saved time and the resultant production costs but we have prevented the loss of aircraft and personnel during flight-test programs and later in the initial operations in tactical units.

One pay-off of the power and size of these facilities is the large test sections which are available both in cross section and in length. Another is the mass flow—the tremendous quantities of air that make it possible to test the latest and largest air-breathing engines which consume hundreds of pounds of air every second. It is also possible to test these monsters under "free flow" conditions which most nearly duplicate the actual flight of the engine through the atmosphere with the attendant problems of air flow both through and around the engine.

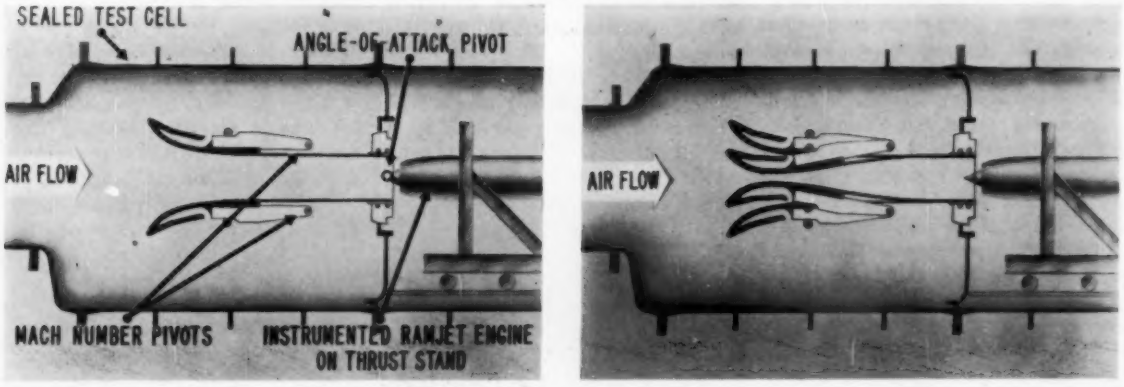
A recent development, spearheaded by one of the engineers of the operating contractor, Aro, Inc., opens new opportunities for tests. A variable and flexible nozzle was perfected which for the first time makes it practicable to vary the speed of the air to the engine while changing the effective "angle of attack" of the engine or missile during the test.

Now it is possible to fly a guided missile through virtually its entire trajectory—up, over, and down. This is of great importance with ramjet engines whose performance varies greatly as the angle of attack is changed. Establishing these operating limits in any other way would be virtually impossible.

GETTING the information at all is important, but it is most valuable when it is in readily usable form. Every engineer knows, from his own experience, how frustrating it is to watch a test and to have a pretty good idea of what happened but of not being able to do anything about it until all the data are tabulated and, some weeks or months later, the report is made available in order that the necessary changes could be engineered and a fix designed.

However, in each of these facilities an on-line data-reduction system is being incorporated. In the Gas Dynamics Facility it is already functioning so well that the data are fed back to the

The variable nozzle in open position, left, and closed position, right, at zero angle of attack.



test engineer so promptly that he can not only make changes in his test program to verify questionable points but can include additional ones if they are called for.

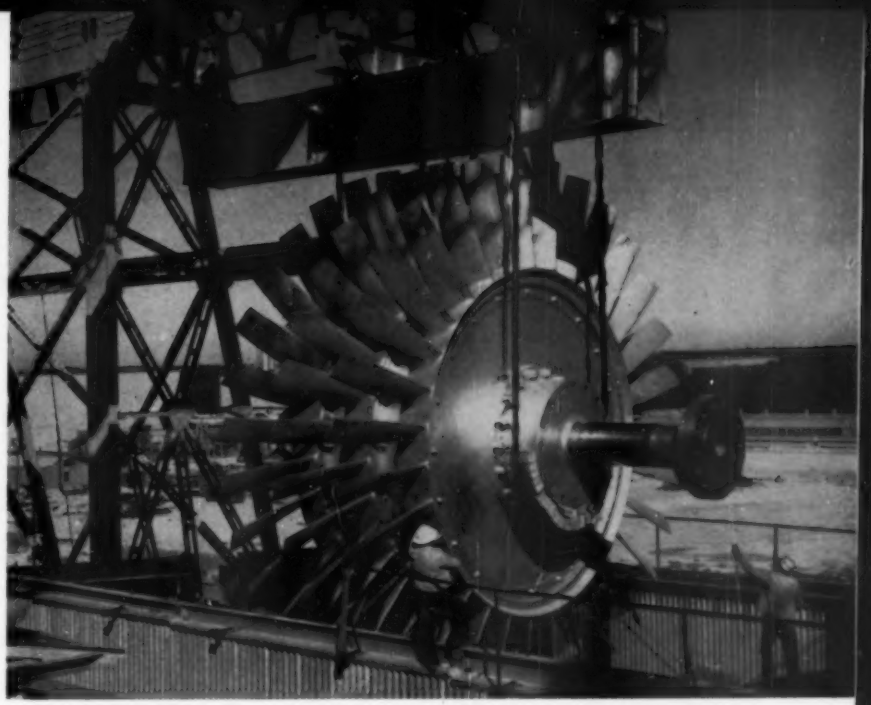
Then, within minutes after he has closed down the tunnel, he can give the company engineer who has witnessed the test a tabulated copy of the data to take back with him to analyze and use as a basis of any design changes.

THIS program has been most effective in developing optimum inlets and ducting on high-performance fighters and in helping the Army in its studies on the Redstone missile.

These computers are especially designed Univacs known as Sperry Rand "ERA-1102's." Each weighs about 10 tons, contains 2,700 vacuum tubes, 3,000 crystal diodes, 700 relays, and 4 miles of wiring. During operation, they generate so much heat that two 5-ton air-conditioning units are required to cool them.

The data from the instrumented engine or model are translated from analog to digital values in the form of electrical contacts. It is practical to gather and record some 250 observations of a test point within 13 seconds after the engine reaches this point.

These raw data are fed directly into the Univac in a truly automatic operation for no human reading of film, punching of cards or tapes is necessary. As the instructions for processing these data have already been introduced, the machine starts spinning and in seconds the finished analysis is printed on the battery of typewriters and graph-plotting machines as well as permanently recorded on a tape which can be reviewed later on in connection with similar flights or could transmit the information by teletype.



Giant rotor blades, weighing 1,200 pounds each, will "push" the airflow through the transsonic circuit of the Propulsion Wind Tunnel at Tullahoma, Tenn.

These major facilities have several basic differences. For example, while both the Engine Test Facility (ETF) and the Propulsion Wind Tunnel (PWT) test air-breathing engines, the ETF is "once through" while PWT is a balanced, recirculating, closed-circuit system. This means that in the ETF a relatively simple cycle is possible.

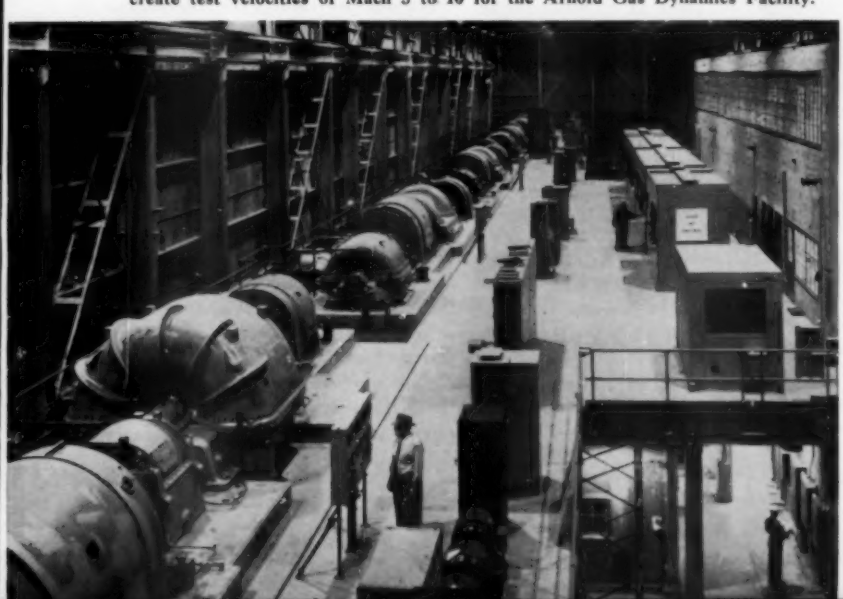
Air is brought in one side of the test cell, compressed, cooled and dried, forced into the test cell, and then exhausted to the atmosphere, usually through another bank of exhausters to give maximum pressure differential and simulated altitude conditions.

In the PWT, once the cycle is started an elaborate "balancing" system must come into play so that the products of combustion of the operating engine under test may be removed and the same amount of make-up air under proper conditions added to maintain a constant and uninterrupted flow.

UNDER operating conditions this will require—in addition to the 216,000 horsepower in the tunnel drive system, the use of about 200,000 horsepower from the ETF and the Ramjet Addition exhauster and compressor systems and sometimes air from the GDF high-pressure tank. There is lots of air moving, for the flow past a given point is 13,000,000 cubic feet a minute.

There is still another requirement for supplemental power and for the "plenum evacuation system." This was incorporated as a result of research and experiment conducted by Aro and AEDC which demonstrated that by properly perforating the walls of the test section, surrounding it with a plenum chamber, and then sucking off a small percentage of the air circulating in the tunnel, not only could more accurate and consistent results be obtained but larger and longer models and sections could be utilized.

The 100,000-horsepower compressor line an eighth of a mile long is used to create test velocities of Mach 5 to 10 for the Arnold Gas Dynamics Facility.



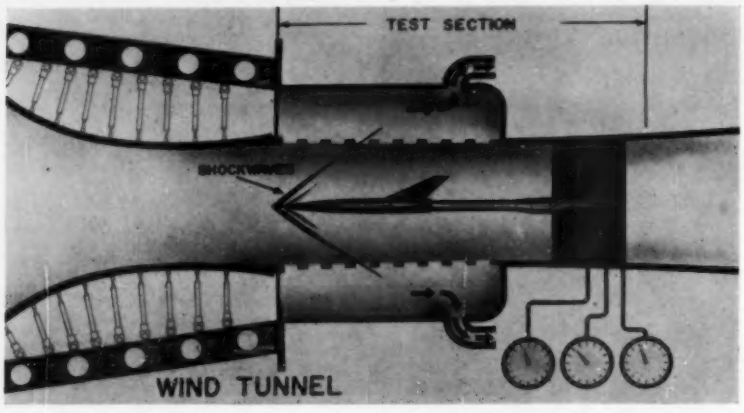


Diagram of Arnold's wind tunnel with porous walls and plenum evacuation, especially designed to absorb instead of reflect supersonic shock waves.

Such a system is essential in the transsonic leg and very desirable in the supersonic leg. The compressors which withdraw this air from the plenum and then return it to the tunnel add about 90,000 horsepower each to the already heavy requirements.

PWT has continuous-flow tunnels while the Gas Dynamics Facility has both the continuous and intermittent type, though only the latter is in actual operation today. To operate the larger tunnels it was necessary to construct both high- and low-pressure vessels to be used in balancing the tunnels. Pending completion of the larger continuous tunnels, these adjuncts were used effectively to operate intermittent tunnels with 12 x 12-inch test sections.

In fact, much of the research work in the proper design of the larger tunnels, etc., was done in this Tunnel E-1 and another 12 x 12-inch transsonic model tunnel. Another tunnel is under design to use these facilities and to obtain much higher Reynolds numbers than normally available in tunnels and or encountered in actual flight.

THE high-pressure flask is a built-up tank 3 feet in diameter and 720 feet long. In many ways it resembles a built-up gun tube. It weighs one ton per foot and holds 50 tons of air at 4,000 pounds per square inch. This introduces a further complication, for at this pressure air has almost one fourth the density of water and is quite viscous—almost like having your water pump handle cold molasses. The vacuum sphere is 72 feet in diameter and before the run is normally evacuated to 28 inches of mercury.

The several tunnels in the Gas Dynamics Facility have two unique characteristics in addition to the wide and high range of speeds available. One is the high Reynolds number, ensuring results comparable to actual flight conditions, and the other is the extreme accuracy and uniformity of air flow throughout the test section. Range of error has been reduced to a phenomenal 1 to 5 per cent.

AN interesting phenomenon in these tunnels is the liquefaction of the air as it expands through the variable nozzle unless the air is preheated to a temperature of 1,200 to 1,500 degrees Fahrenheit. This, of course, complicates the design and fabrication of the ducting and valving and requires special precaution to ensure that the walls of the flexible nozzle are not distorted and thus give inaccurate velocities in the test section.

Air heaters are required for a different purpose in the Engine Test Facility for there, and particularly in the Ramjet Addition, they are used to heat the air to simulate the conditions encountered at higher speeds.

One reason the Engine Test Facility has been in operation as long as it has is the extensive use of much of the equipment which was taken from the German Engine Test Facility near Munich. ETF is far from a "Chinese copy," but it has incorporated many of the motors, compressors, coolers, etc., with ducting, test cells, valves, cooling equipment, transformers, etc., of American manufacture to complete a more flexible and versatile test facility than the original one, and has done it with savings of millions of dollars as well as of time.

Another example in the dollar savings made during the design of the Center was the selection of the compressors and the drive for the Gas Dynamics Facility.

Initial studies indicated 216,000 horsepower were required to drive the various compressors.

By judicious selection of compressors and grouping them so as to equalize power loads, they were able to meet the needs with 97,500 horsepower arranged in 5 units with standard motors which also reduced the requirements for spare parts and minimized down time because of motor failure. Even so, this compressor line is almost an eighth of a mile long.

Sometimes the economies are reflected in improved performance. In the Propulsion Wind Tunnel by using the porous wall test section and certain other innovations, it was possible to reduce the altitude simulation at the higher Mach numbers by another 10,000 feet.

Had these changes not been incorporated this would have been possible only by doubling the horsepower of the main drive—and adding 216,000 horsepower is no mean trick. A higher velocity also has been achieved than was recommended by the Research and Development Board and in the "Unitary Wind Tunnel Plan."

EXPENSIVE as these tunnels are to run, they are really more expensive to keep idle. To reduce this idle time to the minimum, every effort is made to have fully instrumented "backup" engines and models in reserve. Many times this just isn't practicable because the experimental and developmental engines are too expensive and just aren't available.

Probably the most effective step toward increasing the utilization of these facilities has been the procurement of multiple removable test sections and a transfer car.

The test sections for the Propulsion Wind Tunnel Facility belie their name for they cost well over three million dollars per tunnel, weigh almost half a million pounds each, and are transferred from the Model Installations Building where the manufacturer can install his engine and its nacelle or the missile to be tested, to the test section

of the wind tunnel on a car which itself weighs a quarter of a million pounds and rides on two standard-gauge double tracks of the heaviest rails spaced approximately 30 feet from center to center. These mounts, which incorporate the "perforated wall" were so large they had to be assembled in the tunnel.

Although this article is primarily concerned with the physical facilities and the why and how of them, it would be inappropriate not to mention the way the Center is organized to manage them.

EARLY in the inception of the Center, the Air Force and the Department of Defense reached two basic decisions—one that the Army Corps of Engineers would be the construction agency and would establish a special Engineer district with the construction of AEDC as its only mission, and the other that an industrial management concept was essential.

Sverdrup & Parcel, Inc., the architect engineering firm that made the preliminary studies upon which the actual site selection was made and who continued to design many of the facilities, organized a wholly owned subsidiary, "Aro, Inc.," to operate the facilities as directed by the Air Force. This direction is assured by having a strong Center commander, who is also the contracting officer, assisted by a small staff.

These facilities are tremendous and, measured in terms of today's equipment, entirely adequate. They are complex and take a long time to design, for if they are to be useful they must be in advance of the state of the art. After the design is firmed up the construction is long and expensive for there are problems in fabrication of these large machines as well as in their design.

For example, in the Propulsion Wind Tunnel compressor system ways had to be found to detune the rotor blades to prevent dangerous resonant frequencies. Detuning had been used in turbines and in small compressors, but it was no simple scaling operation to make it applicable to a system of this size, which has an inertia of 84,000,000 pound-feet squared and is driven by the largest electric motors ever built.

INITIAL planning for the Center and its testing facilities was started over ten years ago and was based on trends. It was not known at the time specifically what jet engine or missile or weapons system would be supported. If we are to take full advantage of advances in the state of the art and of new fuels and materials we must have adequate research and development facilities to test and investigate them.

By the time a new idea or material is so well developed it can be incorporated in a specific engine or weapons system, it is far too late to develop the requirements for the facility, secure its approval by the numerous agencies of the Department of Defense and of Congress, obtain the funding for it after receiving the authority to build when and if funds are appropriated, design it, construct it, and place it in service.

It is essential, if AEDC is to continue as an advanced research and development center and is not to slip into obsolescence and mediocrity, that a way must be found to plan, finance, design, and construct additional facilities to keep abreast of advances in the state of the art. Such a program will be expensive but not nearly as much so as having a second-best Air Force in time of emergency.

All poker players know there is nothing worse than a second-best hand. It is doubly true when the security of our Nation and peace of the world may be at stake.

EDITOR'S NOTE.—A previous article on the Arnold Engineering Development Center, entitled "More Power for Air Power," by John A. Killick, appeared in the November-December 1953 issue of ORDNANCE. It described the beginnings of the installation of some of the gargantuan equipment now being used at the Center.

Air flow in the Propulsion Wind Tunnel is controlled by these giant turning vanes located at a corner of the transsonic circuit.

New TNT Loading Method

The development of a continuous melt pour process using the flaked explosive produces higher-quality shell on simple automatic equipment quickly, safely, and without the need for highly skilled operators

Col. O. M. Jank

THE present-day concept of shell loading actually had its beginning in the latter part of the nineteenth century when the French developed picric acid to the point where it could be employed in making military explosives. Picric acid was used by the major armies of the world until the use of TNT became prevalent in the years immediately preceding World War I.

Early shell-loading techniques saw the TNT being melted in a suitable vessel and poured directly into the projectile. Needless to say, the resulting cast was quite poor. Later, in an effort to improve quality, the liquid TNT was drawn from the melting kettle into a rubber or wooden tub or bucket and stirred with large wooden paddles not unlike a boat oar in design.

The liquid TNT was stirred until crystals began to appear and then was poured into projectiles. This was the accepted procedure at the beginning of World War II.

IN World War I, shortages of TNT caused extensive use of various mixtures of TNT and ammonium nitrate, a situation which still existed in the early stages of operation of present loading plants. It may very well be that from this experience the idea was born of adding flake TNT to its liquid to form a slurry.

In any event, the pouring of slurries became the accepted method of cast-loading shell during World War II.

Colonel Jank is general manager of the Lone Star Ordnance Division, Day & Zimmerman, Inc., Texarkana, Tex. This article was originally presented as an address before the Loading Committee of the A.O.A. Bomb and Artillery Ammunition Division meeting held recently at Joliet Arsenal, Joliet, Ill.

These slurries were prepared by melting TNT in a suitable vessel and admitting it to a large kettle or mixing vessel where flake TNT was added and mechanically stirred.

Prior to 1943, all TNT loading of projectiles was accomplished by means of rubber buckets which were filled with the slurry and then poured into the item to be loaded. Later a rubber hose equipped with a nutcracker valve was attached to the mixing kettle and projectiles were loaded direct from the kettle. In mid-1943, a multiple-pour volumetric device was developed.

These mechanical refinements were largely responsible for the high degree of production achieved by the industry during the Korean conflict.

It should be noted here that the quality of the end product still depended largely upon the operator assigned to the blending process. This operator was, and is, the key man to the success of the batch-pouring system. Assuredly other factors, such as local weather conditions, control the quality, but the operator can compensate for these factors by predetermining the amount of flake TNT to be added to the mixture.

Studies of reports from different installations indicate that cast loading defects usually occur in concentrated periods. That these defects usually could have been avoided by compensation in the blending process indicates the high degree of skill the operator must possess and to what degree quality in the batch system must depend upon the human factor.

THE American shell-loading industry, despite the many advances of recent years, is still hampered by the lack of a standardized process for pouring TNT; that is, one that can be used throughout the industry without regard to local conditions.

Any such process should, of course, have full safety approval, be as simple in design as possible, and simple to operate. To be desirable, it should not embrace any complicated machinery or equipment which would require highly trained technicians to operate and to maintain.

With this view in mind, a program of research and development was instituted at the Lone Star Ordnance Plant to develop a continuous TNT melt pour process which would meet the needs of the industry for a standardized process and one that was simple and easy to operate.

The program was predicated on the idea that it would be desirable to incorporate TNT at a fixed percentage to liquid TNT on a continuous basis in such a manner that the flakes would become coated with liquid so that the liquid in the region of the flakes would be cooled and crystallize out. Each such flake so added would help cool the melt. It was believed that cooling obtained in this manner would materially lower the cooling time required per shell.

TO test the feasibility of adding a cold solid material in the form of small flakes to its liquid form, suitable apparatus was set up in the chemical testing laboratory. Fisher's bath wax (with a melting point of 141 degrees Fahrenheit) was then melted and poured.

A fixed percentage of flaked wax was incorporated into the melt as it was being poured, and the cooling effect of the flaked wax was observed.

The test clearly showed the practicability of incorporating flake material into its liquid.

Encouraged by the favorable results obtained with the laboratory model, it was decided to build a prototype production model. Once the prototype model was installed, research work was resumed with two main objectives in view: (1) To produce a shell with a uniformly higher charge density, and (2) to effectively reduce the cooling time per shell.

To accomplish these objectives a large number of splits of various caliber were poured under different conditions. The most important variables were the amount of flake added and the temperature of the melt. Consideration was given to other factors which might have an effect upon the quality of shell poured, such as room temperatures, flake temperatures, the temperature of the water bath, and the temperature of the shell body.

The only projectile then being filled with TNT at the Lone Star Ordnance Plant was the 4.2-inch mortar. Experience had indicated that, due to the shape of the cast and the thin sidewall of the shell body, this projectile was one of the most difficult to fill.

Experiments had further indicated that difficulties in filling standard projectiles such as the 105-mm. and 155-mm. would also be encountered in filling the 4.2-inch mortar shell. It was, therefore, decided that we would concentrate on developing a loading technique for the mortar shell in our future work.

THE splits that were poured were sectionalized and examined for defects. The results were very favorable, though some porosity was observed when quantities of over twenty per cent flake were added.

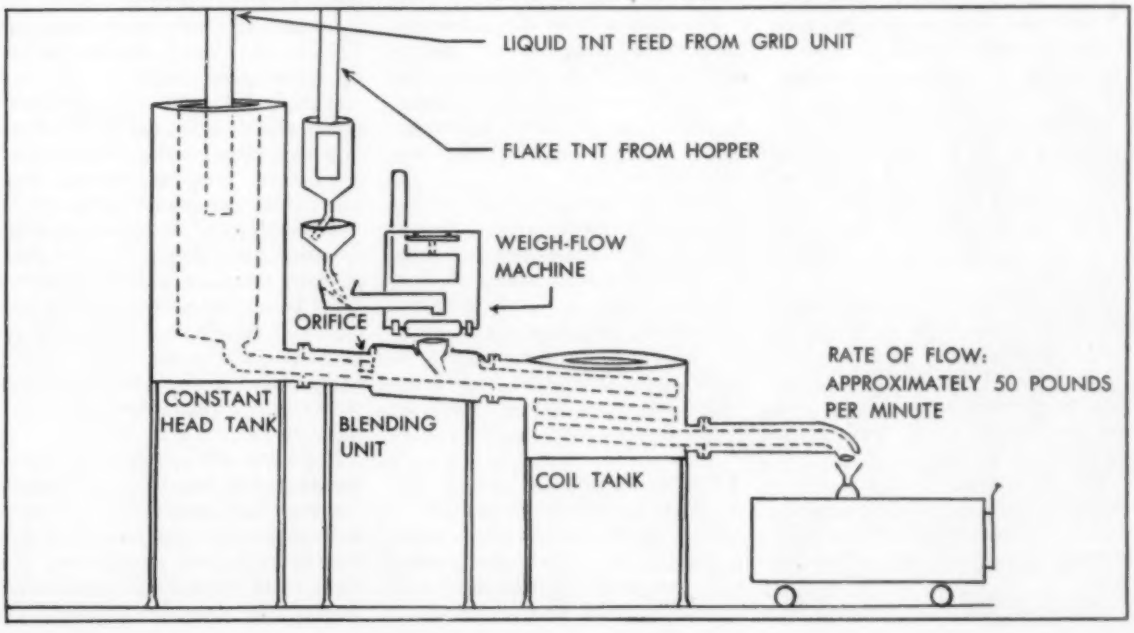
It is suspected that this porosity was caused by too rapid cooling. In point of fact, cooling obtained by adding cold solids is so efficient that it was possible to reduce the cooling time of 4.2-inch mortar shell from six to five hours per shell. The best results were obtained using 11 per cent flake, though good results were obtained when as high as 12.5 per cent flake was added.

All casts that were sectioned and examined for defects showed a flake line that was uniform in height. The height of the flake line being determined by two factors—the amount and temperature of flake that was added to the melt and the temperature of the melt.

TEMPERATURE control is of the utmost importance in the production of high-quality shell whether it be by the batch system or the continuous process. The temperature control effected throughout this process is precise and reliable, enabling one to predict accurately just the quality of shell that will be obtained for a given temperature of melt and flake and percentage of flake added.

Such reproducibility of results is in marked contrast with the batch system where each batch is different even though the most careful attempts are made to produce uniform results.

Production model of the continuous melt pour machine for loading TNT in high-explosive projectiles.



Upon completion of the basic research work, it was decided to build an experimental production model that would yield the following advantages which had been enumerated from work on the prototype model:

1. Be safer than the batch system by virtue of lowering load limits within the melt pour building.

2. Leave little to the discretion of the operator, making it possible to utilize untrained labor in an emergency.

3. Be sufficiently simple in design as to render the operation of the equipment easy to learn while requiring a minimum of maintenance.

4. Be so designed that all necessary equipment could be located on one floor thereby saving existing space and reducing future building costs.

5. Be inexpensive and easy to fabricate and readily adaptable to existing buildings.

The experimental production model as constructed gives these advantages over existing methods. The production model was built to accommodate the capacity of one grid unit located on the second floor of the melt pour building. Other equipment, the arrangement of which may be seen from the schematic drawing on page 175, consists of a constant-level head tank, a melt-flake blending unit, a conditioning tube or coil tank, and a weigh-flow device.

THIS device consists of an endless belt which is connected with a scale in such a manner that all the material on the belt is continuously weighed. The scale is directly connected with an instrument which controls the air pressure going to the Syntron feeder. This device was added to the production model in order to ensure a more rigid control over the amount of flake added than was possible with the Syntron feeder alone.

Further to assist in this control, segregated TNT flake which is retained on the No. 8 sieve is to be used exclusively for feathering. To ensure flake of a constant temperature, a conditioning oven has been installed on the third floor of the melt pour building.

The constant-head tank is merely a vertical cylinder in which we keep the liquid level constant by means of a differential pressure cell and a Conoflow valve.

The liquid flows from this tank into the melt-flake blending unit where flake TNT is dropped from the weigh-flow machine belt into a funnel and thence falls by gravity into the liquid TNT as it flows by the mouth of the funnel. This accomplishes the incorporation of the flake in the liquid in such a manner that each individual flake of TNT is coated with liquid and no conglomerate results as is normally found when blending is accomplished in the Dopp kettle.

THE slurry then flows through the conditioning tube where some of the heat is absorbed by the cooling water (180 degrees Fahrenheit) but most of it is absorbed by the flake. The slurry delivered at the end of the coil is 176 to 178 degrees Fahrenheit.

The differential-pressure cell consists of a stainless-steel diaphragm which is inserted in the constant-head tank at the bottom with the liquid TNT against the diaphragm. The other side of the diaphragm is vented to the atmosphere.

By a system of levers the movement of the diaphragm is transferred to a flapper nozzle through a feed-back bellows and hence to a pneumatic control instrument which controls the position of the Conoflow valve.

The Conoflow valve consists of a Hills-McCanna valve attached to a springless Conomotor. The Conomotor consists of a diaphragm with air pressure on both sides of it.

The impulse from the differential-pressure cell changes the air pressure on one side of the diaphragm, thus causing it to open and close as needed. In case of an air failure, a reservoir tank is supplied which will automatically close the valve.

In the initial operation of the production model, supplementary charges were poured. Densities averaged, under the old batch system, about 1.58. Density immediately increased, using this procedure, to an average of 1.61. Under the old system the charges had to be cooled for approximately two hours. Under this system they are cooled approximately one hour.

IN order to establish an optimum procedure for this specific machine, in addition to the supplementary charges a number of 4.2-inch mortar shell splits were poured using the new equipment. The splits were sectioned, examined for defects, and density samples taken. The machine was now ready to be used in regular production, and it was turned over to production personnel.

Some 45,000 satisfactory shell were produced. Density samples from each day's production showed that an average cast density of 1.605 was obtained as compared with average cast densities of 1.58 for shell poured by the batch system in the previous three months of operation.

In this respect, a comparison of zone weights for shell poured by the continuous method and those poured by the batch system using the same steel lot, yields the following results:

For shell poured by the cold-solids method in November and December 1955: Zone 1—none; Zone 2—470 rounds (1.06 per cent); Zone 3—42,285 rounds (95.9 per cent); Zone 4—1,340 rounds (3.04 per cent).

Shell poured by the batch system in the month of October 1955: Zone 1—none; Zone 2—816 rounds (2.26 per cent); Zone 3—33,246 rounds (93.45 per cent); Zone 4—1,514 rounds (4.29 per cent).

This clearly indicates that a more uniform shell is being poured by the continuous cold-solids process.

TO summarize, the following has been accomplished at the Lone Star Ordnance Plant as a result of the research program inaugurated there.

A continuous melt pour process for TNT has been developed which offers the following advantages:

It produces higher quality shell and makes possible a substantial reduction in cooling time per shell. The process is safer by virtue of reducing load limits in the melt pour building.

Its simplicity of design and ease of operation make it possible to utilize relatively untrained labor in an emergency because it leaves little to the discretion of the operator, particularly as far as blending is concerned.

Equipment is simple in design and can be easily manufactured at the installation site.

It requires only one floor for operation instead of three employed in melt buildings today which makes it more easily adapted to automation than the existing batch pour system while the absence of complicated equipment renders major breakdown unlikely.

Automotive Gas Turbines

Continuing developments in this new field of propulsion may make possible the application of the turbine engine to commercial vehicles and also may result in its future military employment

2nd Lieut. Richard L. Curl

OUT of the ashes of the Second World War have come many far-reaching scientific and technological advances of great potential for peacetime applications. Particularly significant were, in the field of medicine, the mass-production of penicillin; in the field of power production, the unleashing of atomic energy; and in the field of transportation, the development of the gas turbine as an unrivaled source of power for aircraft.

The phenomenal success of the latter in military aircraft and lately in civilian application has caused many technical groups and private individuals to wonder whether or not the gas turbine could find a more "down to earth" usage as a prime mover in the automotive field where, just as happened in the field of aviation, increased demand for greater power and higher performance is overtaking the capacity of the reciprocating engine.

Much of the material for this paper has been extracted from papers presented to the Society of Automotive Engineers by W. A. Turunen of the General Motors Research Laboratories and A. H. Beaufrere of the Ford Motor Company's Gas Turbine Research Division.

THE inherent potential of the gas turbine for large power outputs has long been known by its ability to handle large quantities of air. Before World War II, however, development was greatly retarded by a lack of suitable materials for high-temperature operation and by low efficiencies of available compressor and turbine components.

This article is based on a term paper prepared by Lieutenant Curl while a cadet at the United States Military Academy. The paper was presented at the Eastern Intercollegiate Science Conference at Philadelphia, Pa., on April 6, 1956. Lieutenant Curl was appointed to the Military Academy from Kansas and was commissioned in the Corps of Engineers upon graduation, June 5, 1956.

The critical power demands of the war, however, added impetus to the development of compressor and turbine units of satisfactory efficiencies, and these improvements, coupled with corresponding achievements in high-temperature alloys, permitted the realization of a part of the gas turbine's potential. This partial utilization of potential met the power demands for aircraft far beyond the capacity of reciprocating engines, and the gas turbine became an unchallenged source of power for high-speed aircraft.

Basically, the gas turbine consists of three major components: an air compressor, a combustion chamber, and a turbine. In most aircraft installations and power-generating plant applications the turbine delivers power for both compression of air and shaft output. This design is too inflexible for automotive power, however, since the torque output drops off rapidly as the speed is reduced from rated or design point speed.

To improve this situation, the dual turbine arrangement shown in Figure 1 appears to be a better choice. Here the compressor is still turbine-driven, but this turbine extracts only enough power to drive the compressor and exhaust the bulk of the high-energy gases. These gases then are utilized by a second turbine to produce the required shaft torque and power.

SINCE the compressor and its drive turbine may be operated independently of the power turbine, it becomes possible to derive maximum torque with the output shaft stationary, a very desirable characteristic in automotive equipment.

The cycle represented in Figure 1 is known as the simple or unregenerative cycle. In addition to the components necessary to this cycle a fourth part may be added to increase fuel economy. This component is known as a regenerator and is a device by which some of the heat from the exhaust may be transferred to the air between the compression and combustion stages thereby conserving fuel and utilizing otherwise "waste" energy.

Thermodynamically, the gas turbine is composed of two isentropic processes and two constant-pressure processes.

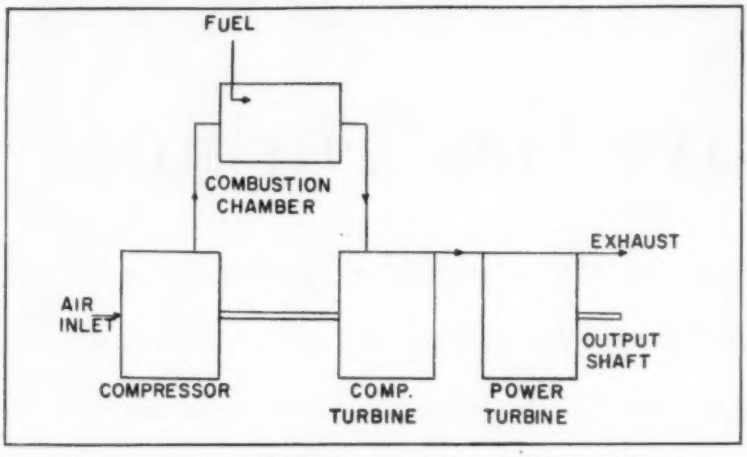


Fig. 1. The simple unregenerative cycle of the dual turbine arrangement.

Figure 2 shows the ideal cycle in which the working fluid is compressed isentropically in the compressor (1-2), heat is added at constant pressure in the combustion chamber (2-3), the hot gases expand isentropically through the turbine (3-4), and then exhaust at constant pressure (4-1).

The line *n*-1 may be taken as the intake to the compressor and the area under it represents the flow work of the intake. The area under 2-*m* represents the flow work of the discharge of the compressor. The area under *m*-3 represents the intake flow work as the air enters the turbine. The area under 4-*n* represents the exhaust flow work from the turbine. The enclosed area *m*-3-4-*n* represents the work of the turbine. The enclosed area 1-2-3-4 represents the net work output of the combined unit.

THE net work may be obtained by an application of the steady-flow equation, as well as by cycle analysis. Thus, assuming adiabatic compression ($Q = 0$) and $\triangle KE = 0$, the work of the compressor from the general energy equation is:

$$W_c = h_1 - h_2 = wc_p(T_1 - T_2)$$
$$= -wc_p(T_2 - T_1)$$

Similarly the work of the turbine is:

$$W_t = h_3 - h_4 = wc_p(T_3 - T_4).$$

The net work is the algebraic sum of these work quantities, or:

$$W_{net} = wc_p(T_3 - T_4 - T_2 + T_1).$$

The thermal efficiency is:

$$e = \frac{W}{Q_a} = 1 - \frac{T_4 - T_1}{T_3 - T_2}$$

The efficiencies of the component parts of the gas turbine have a very pronounced effect on over-all plant performance. Component efficiencies must be in the order of eighty-five per cent for the turbine and eighty per cent for the compressor for the over-all plant to meet minimum standards of thermal efficiency and hence of fuel consumption.

A drop of only ten per cent in both component efficiencies results in a reduction of thermal efficiency from more than fifteen per cent to less than eight per cent—a most uneconomical figure.

Requirements for a compressor for use in an automotive gas turbine call for a unit of relatively high efficiency, simple in design, small in bulk, low in cost, and capable of producing a compression ratio of 3.5 to 1 or better.

The answer seems to be a centrifugal compressor. There are several centrifugal compressors now available which fit all these requirements. In addition, application of the variable-area blade principle on the driving turbine by the Ford Motor Company in their gas turbine development has enabled them to reach a pressure ratio of 4:1 with very good surge characteristics.

Careful design of the combustor is very important in holding friction or aërodynamic losses to a minimum. These losses are a function of the velocity, density, and viscosity of the gases flowing and the linear dimensions of the unit. Also, parts of the burner and the ducts between the burner and turbines are subjected to the highest temperature-pressure combination to be found in the plant and therefore require special attention as to material and design.

Since increased efficiency follows from increased operating temperatures

$$\left(e = 1 - \frac{T_4 - T_1}{T_3 - T_2}\right)$$

we wish to push our operating limit as high as possible. Recent rapid development of heat-resistant alloys has made practical operating temperatures which only a few years ago were considered impossible.

It should be noted at this point that increased operating temperatures affect the specific air requirements by reducing them, thus easing compressor requirements for a given output. This has a significant effect on the idle fuel consumption, as the fuel requirements are a direct function of the installed pumping capacity.

FORD Motor Company's test results of a can-type burner used to explore the wide air-fuel mixture limits of over 300:1 required in automotive power plants with high fuel economy show that pressure drop increases almost linearly as the Mach number of the incoming air increases. The associated pressure-drop as a function of inlet Mach number dictates extreme care in burner design, particularly in a regenerative cycle where the regeneration tends to force high burner inlet temperatures and correspondingly high inlet Mach numbers.

Most of the discussion preceding this section which concerns high temperature limitations applies to the turbines used to power the compressor and final drive. As the limiting condition is a result of a combination of operating temperature and stress, higher temperatures can be tolerated if the stresses imposed are lowered. This results through careful design and construction.

For the sake of mechanical simplicity both the compressor turbine and the power turbine should be designed as simple stage radial inflow types. These units are simple, rugged, and capable of the high efficiency demanded (eighty to eighty-seven per cent).

IT was mentioned in the first section that the addition of a regenerator or heat exchanger to the plant greatly increases fuel economy. It should be remembered that this unit utilizes the hot exhaust gases to preheat the air entering the combustion chamber;

therefore less fuel is required to reach the operating temperature. This is more clearly shown in Figure 3.

In the case of perfect (100 per cent) regeneration shown in Figure 3, the area *a-2-m-b* (heat received by the air from 2 to *m*) is equal to area *c-n-4-d* (heat given up by the exhaust gases from 4 to *n*). Only the heat from *m* to 3 has to be supplied from an outside source, while we are using the heat from 4 to *n* which would otherwise be thrown away.

Requirements for a regenerator for automotive use include high effectiveness, compact size, and simple design. These conditions were met by the Ford Motor Company with a regenerator of the rotary-matrix type. The regenerator matrix consists of a porous metal disk which revolves at very low speed through the flowing gas and air stream. These streams are separated by a set of rotary face seals.

The metal passage walls of the matrix soak up the heat from the turbine exhaust gas and continually return most of it to the compressed air.

Figure 4 shows the importance of regeneration on fuel economy as compared with other factors giving high efficiency. Curve 1 is the simple cycle (no regeneration), with operating temperature of 1,600 degrees Fahrenheit and a pressure ratio of 4:1. Curve 2 is the simple cycle with the maximum temperature raised to 2,500 degrees Fahrenheit and a pressure ratio of 9:1. Curve 3 is the regenerative cycle with maximum temperature of 1,600 degrees Fahrenheit and a pressure ratio of 4:1. Component efficiencies are assumed the same for all these conditions at N_c = 80 per cent and N_t = 85 per cent.

If the automotive gas turbine is ever to compare favorably to the reciprocating engine in economy of operation, effective regeneration must be achieved.

Now that we have our component parts, less the engine accessories (starter, fuel system, lubricating system, etc.), there remains the problem of assembling these parts efficiently in order to utilize minimum space without sacrificing component efficiency.

BEFORE any small gas turbines actually were built and installed in automotive vehicles, a number of problems and possible disadvantages confronted their use. Many of these problems have been overcome, and many have proved to be of very minor significance or of no importance at all.

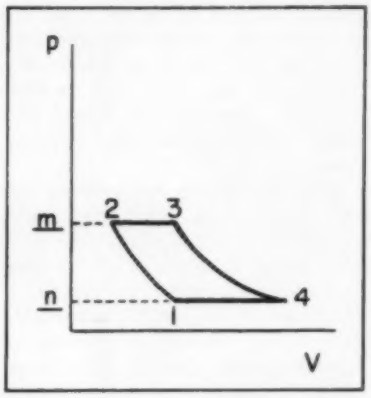


Fig. 2., above, ideal gas turbine cycle.
Fig. 3., below, perfect regenerative cycle.

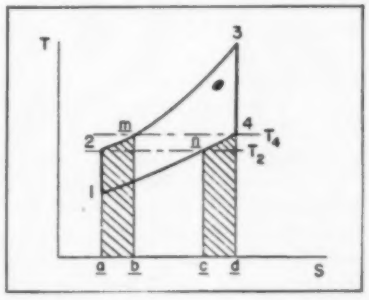


Fig. 4., below, shows importance of regeneration on fuel economy.

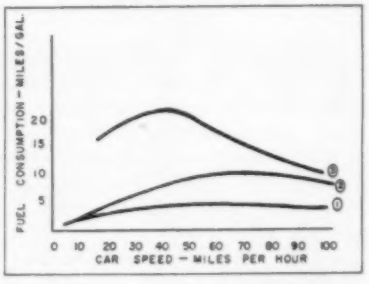
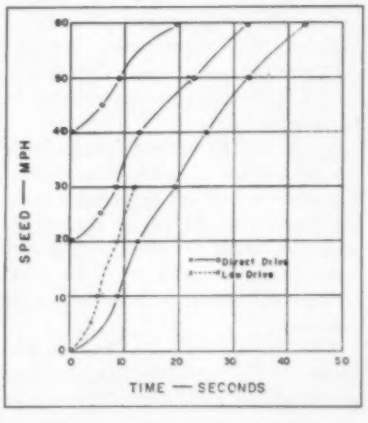


Fig. 5., below, acceleration characteristics of Turbo-Cruiser transit bus.



However, a few still stand as major obstacles on the path of complete acceptance of the automotive gas turbine.

Fuel consumption is the major item on the list of disadvantages of the gas turbine. Since the gas turbine is at its best when delivering large horsepowers and since the bulk of automotive use is at part throttle, extreme care in the design was necessary to minimize this effect.

The results of improved component efficiencies, minimized internal pressure losses, raised operating temperatures, and the use of the regenerator have put the gas turbine in competitive range of the reciprocating engine.

Furthermore, the gas turbine is quite insensitive as to the type of fuel required, operating equally well on gasoline or low-grade Diesel fuel.

IT will be remembered that the initial selection of the dual or free-turbine arrangement was made to take advantage of its very favorable torque curve. The maximum torque, obtained at stall, is more than twice that of design point torque and decreases almost linearly as shaft speed increases to design point.

The horsepower, being a function of torque and shaft speed, does not peak sharply but presents maximum power over a broad range of speeds.

It should be understood that the maximum torque is produced by holding the driveshaft while the gasifier section (combustor, compressor, and the compressor drive turbine) are operating at maximum speed.

From a standing start in direct drive with the engine initially idling there will be a momentary delay in vehicle acceleration while the gasifier section comes to speed. Acceleration characteristics of the GM Turbo-Cruiser transit bus shown in Figure 5 exemplify what can be expected under these conditions.

The over-all acceleration time is better than in its commercial counterpart operating under similar conditions.

Since the operating temperature of a gas turbine is high and remains essentially constant, the engine heat problem had been felt to be great. Experience has proved, however, that a simple aluminum radiation shield surrounding the hot zone of the engine is extremely

effective in keeping engine compartment temperature at the same level as with conventional engines.

The specific air consumption of a gas turbine is in the order of four to ten times that of a reciprocating engine; hence the air-handling ducts, both inlet and outlet, are larger in the same proportion and encourage an entirely new design concept in the engine installation.

The air-filtering requirements are negligible in the gas turbine as compared with the reciprocating engine. Experience indicates that the air should be strained rather than filtered to keep out the large particles.

The name "gas turbine" immediately calls to mind the picture of turbo-powered aircraft with an enormous volume of high-energy gases flowing from the rear. This condition is naturally impossible for the public highways and so was treated as a major disadvantage of the automotive gas turbine.

THIS condition is not found in the present design for automotive gas turbines. It is true that the exhaust volume is great compared with conventional engines; however, the exhaust-gas temperature is not as high as in the conventional installation if a regenerator is used.

The problem here is one of design for volume more than high temperatures. One suggested design for automobiles has the exhaust discharged under the front fenders, behind the tires; this seems a workable and publicly acceptable solution.

From the operator standpoint, the control of the engine is equally as convenient as that of a piston-engine installation. A conventional accelerator pedal actuates a needle-type fuel-control valve. Only the transient condition of operation must be monitored, as a sudden surge of fuel to the engine at low speeds could cause an overtemperature condition while the gasifier adjusts its speed to the new fuel setting. A simple accelerator limiter may be used to control the rate at which the fuel is introduced to the engine during speed increases.

THE unmuffled version of the gas turbine is a very noisy engine as any one who has been near a jet fighter warming up can verify. However, reduction of the noise level of these smaller engines is not so great a problem as first anticipated. Most of the noise, at least the most disagreeable sort, emanates from the air inlet to the compressor. This is of high frequency, between 2,000 and 7,000 cycles a second, and can be satisfactorily absorbed by many available materials.

In working with gas turbines one uses 1,000 r.p.m. increments in the same manner as 100 r.p.m. increments with piston engines. The gasifier idles at around 8,000 r.p.m. and reaches a maximum of 26,000 r.p.m. The matter of gyroscopic effect is easily solved by making the two turbines rotate in opposite directions.

In spite of the high speeds the unit is as safe as any contemporary engine. The shrouds surrounding the turbine wheels are steel forgings heavy enough to contain any bucket fragments. The most serious failure which could occur would be a burst turbine disk. With proper design consideration and large safety factors this possibility is negated.

A gas turbine of the type discussed is a very rugged and easily maintained unit. Proper forging and machining techniques have been developed from past experience, and failures are rare even under severe test conditions. Each of the major components can be removed and serviced as a unit.

THE gas turbine is very easy to start, only a standard 12-volt system being necessary. Only in starting is the electrical system necessary to the engine itself. To start the GM engine, first the starting motor and iginition system are energized. The gasifier section is brought up to 3,000 r.p.m. and a solenoid valve in the fuel line just ahead of the nozzles is opened.

Combustion then begins and the starter is held on until the gasifier reaches about 6,000 r.p.m. The entire sequence takes about twenty seconds. Cold weather poses no special problems to starting, even under subzero weather conditions.

One of the still-present drawbacks to the gas turbine in automotive application is the lack of any appreciable braking supplied by the engine during deceleration. With the power turbine and transmission independent of the compressor, the engine is practically freewheeling.

This imposes rather severe requirements on the vehicle brakes and may necessitate the utilization of some supplementary dynamic braking device. On the GM experimental vehicle, the Firebird, flap brakes similar to those on aircraft are used.

In a commercial vehicle handling large loads over steep terrain it is possible for the engine to supply braking torque. As the vehicle begins its descent of a steep grade the transmission may be shifted into reverse. This causes the power turbine to rotate backward and, with gasifier speed selected to maintain proper retarding torque, the vehicle can descend at any speed without using the vehicle brakes.

BEARINGS and lubrication requirements in present designs are not as severe as previously feared. The oil, in addition to providing lubrication, is used to cool the high-speed bearings. In all cases these bearings are jet lubricated.

The lubricant is never exposed to the combustion area or to the products of combustion as in the reciprocating engine, hence it remains clean for long periods of operation. Oils with a rather low viscosity and with little tendency to foam must be used.

One of the great advantages of the gas turbine is its weight-to-power ratio. Present automotive designs give a ratio of approximately two pounds per horsepower for power plant and drive as compared with better than six pounds per horsepower with the conventional piston engine and drive.

At the present time the cost of the gas turbine is higher than a conventional engine due largely to the cost of the alloys necessary for high-temperature operation. These alloys are new in the field of metals, and their quantity production is not yet perfected. As the demand for them increases, production techniques and facilities will improve, with a resulting decrease in cost.

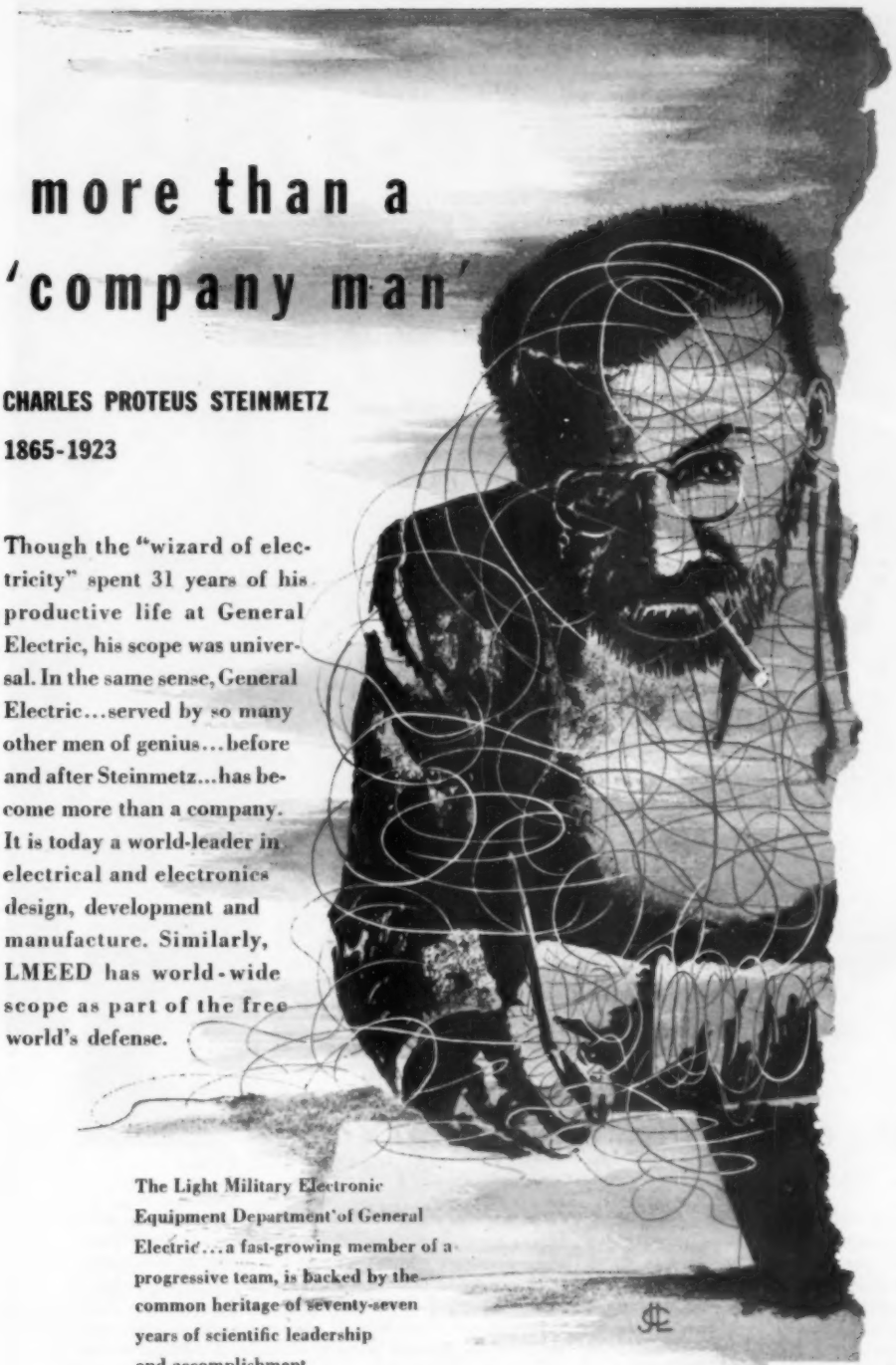
The gas turbine is much more adaptable to mass production than the piston engine, and, although the quality of the necessary metals is greater, the saving in quantity used balances this out.

THE initial application of the gas turbine may well be in the heavy hauling field, where the horsepower shortage is most acute. Then, too, the military should become interested in the gas turbine for its ruggedness, ease of maintenance, flexible fuel requirements, light weight, and ease of starting.

more than a 'company man'

CHARLES PROTEUS STEINMETZ

1865-1923



Though the "wizard of electricity" spent 31 years of his productive life at General Electric, his scope was universal. In the same sense, General Electric...served by so many other men of genius...before and after Steinmetz...has become more than a company. It is today a world-leader in electrical and electronics design, development and manufacture. Similarly, LMEED has world-wide scope as part of the free world's defense.

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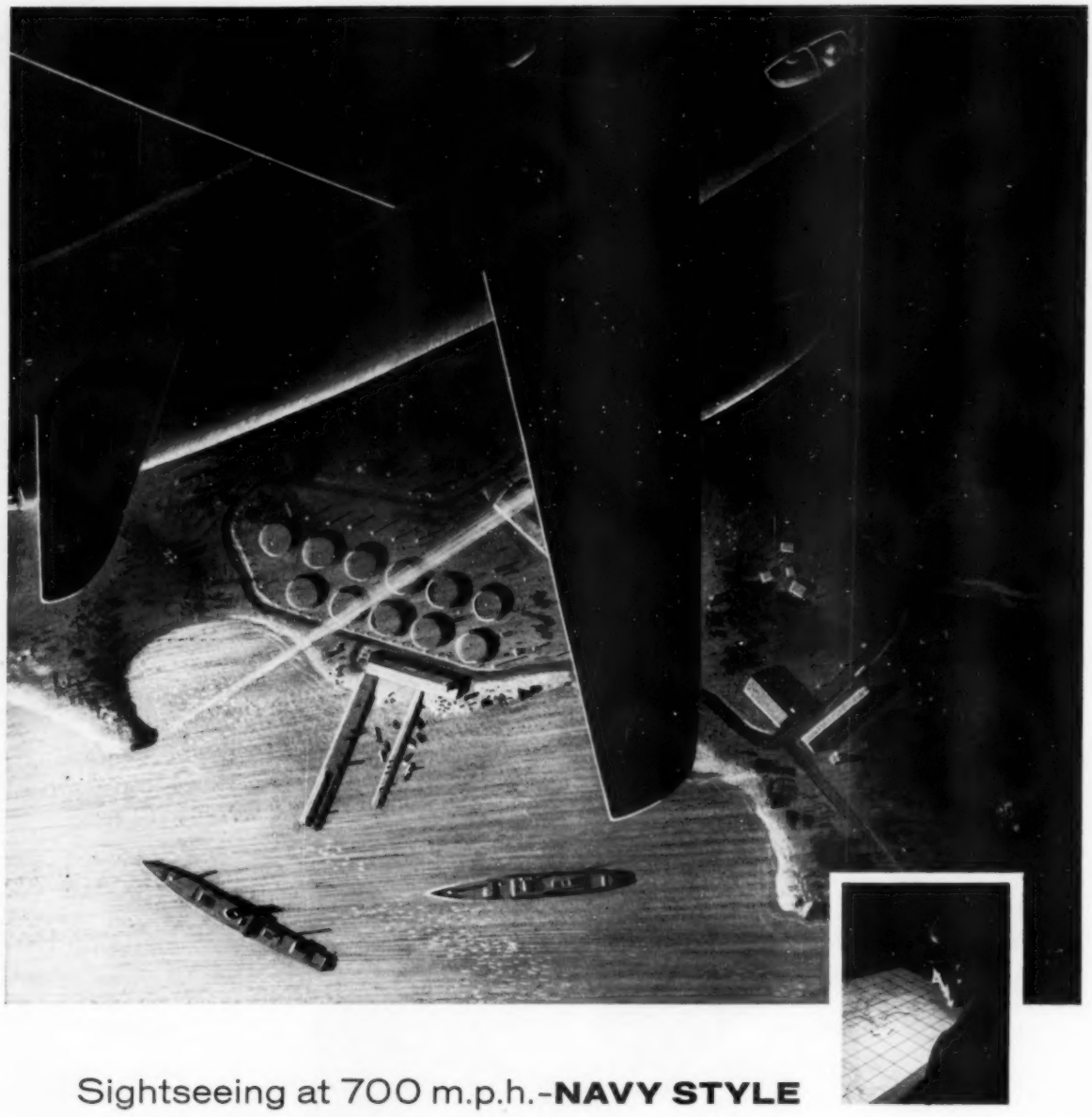

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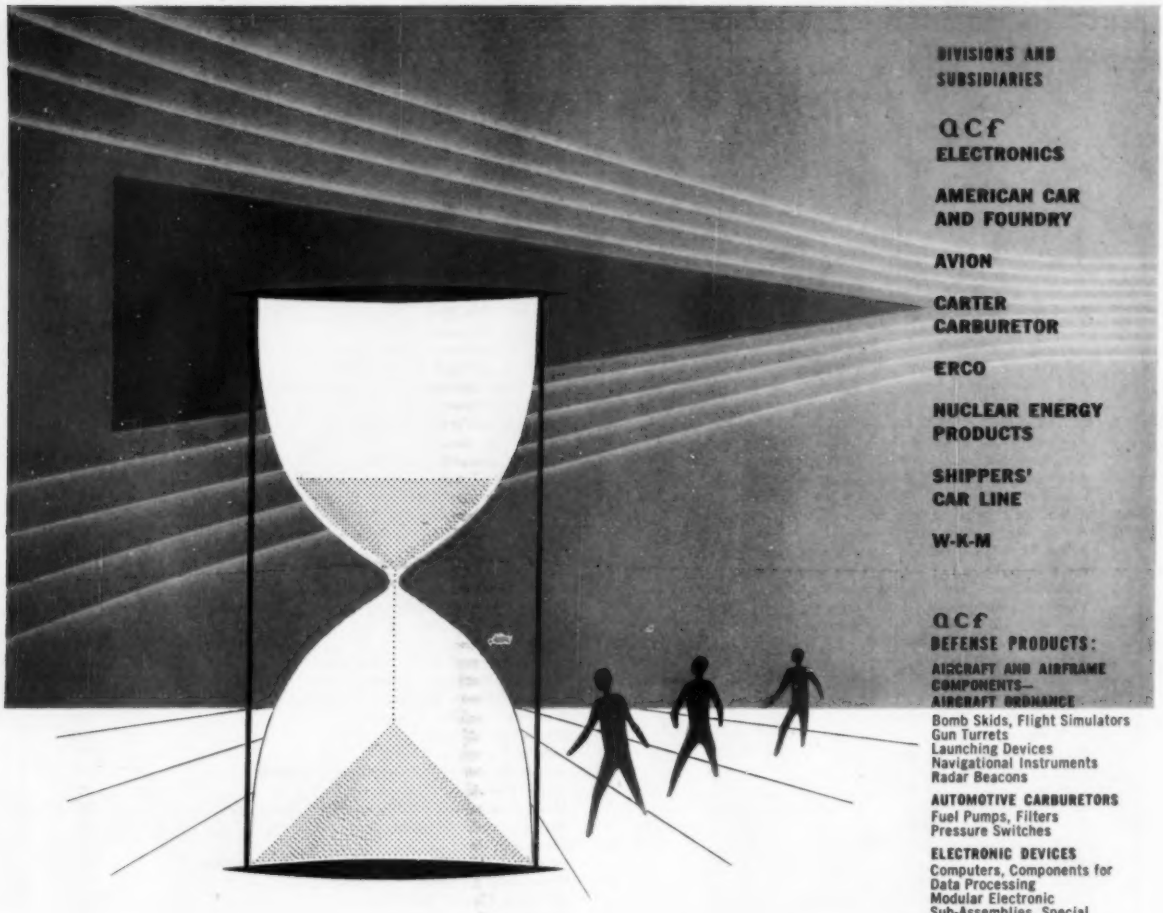
Index of Advertisements

JULY-AUGUST 1956

The following companies have shown by their interest in the design and production of ordnance that they are ready to serve the United States through industrial preparedness for national security and peace. Such companies as these are indicative of the industrial strength of the Nation upon which the military might of the armed forces depends.

	Page
AC Spark Plug Division, GMC	20
ACF Industries, Incorporated	184
Admiral Corporation	81
Aetna-Standard Engineering Company	114
Alco Products, Incorporated	158
Allis-Chalmers Manufacturing Company	134
Allison Division, GMC	123
Aluminum Company of America	87
American Machine & Foundry Company	103
American Potash & Chemical Corporation	86
American Welding & Manufacturing Company	148
Arma Division, American Bosch Arma Corporation	IV Cover
Arnold Engineering Company	105
Atlas Precision Products Company	130
Avco Manufacturing Corporation	Facing 33
Baldwin-Lima-Hamilton Corporation	153
Barnes Company, W. F. and John	27
Bausch & Lomb Optical Company	100
Bell Aircraft Corporation	121
Bell Telephone Laboratories	93
Bendix Aviation Corporation	125
Products Division	141
Products Division—Missiles	90
Scintilla Division	144
Bermite Powder Company	77
Bliss Company, E. W.	13
Buffalo Forge Company	155
Bundy Tubing Company	21
Burroughs Corporation	17
Carlstrom Pressed Metal Company	164
Caterpillar Tractor Co.	79
Chance Vought Aircraft, Inc.	101
Cincinnati Milling Machine Company	89
Clark Equipment Company	19
Clary Corporation	75
Cleveland Container Company	80
Cleveland Pneumatic Tool Company	135
Collins Radio Company	140
Continental Aviation & Engineering Corporation	32
Convair Division, General Dynamics Corporation	III Cover
Curtiss-Wright Corporation	165
Dana Corporation	154
Danly Machine Specialties, Inc.	31
Douglas Aircraft Company	16
Dow Chemical Company	157
Dow Corning Corporation	109, 130, 163
Dresser Industries, Inc.	132
DuKane Corporation	110
Du Pont de Nemours & Company, E. I.	
Explosives Department	85
Grasselli Chemicals Department	113
Eastern Tool & Manufacturing Company	146
Eaton Manufacturing Company	161
Emhart Manufacturing Company	10
Exact Weight Scale Company	161
Fairchild Engine and Airplane Corporation	131
Farnsworth Electronics Company	84
Fellows Gear Shaper Company	102
Ferro Corporation	163
Fonda Corporation	26
Ford Instrument Company, Division Sperry Rand Corporation	8
Foster Wheeler Corporation	147
Fuller Brush Company	163
Gar Wood Industries, Inc.	94
General Dynamics Corporation	Facing 32
General Electric Company	150
Light Military Electronic Equipment Department	162, 164, 181
General Mills, Inc.	142
Gottscho, Inc., Adolph	126
Gray Manufacturing Company	95
Great Lakes Steel Corporation	11
Heckethorn Manufacturing and Supply Company	3
Hiller Helicopters	76
Hobart Manufacturing Company	9
Hoe & Co., Inc., R.	6
Hoffman Laboratories, Inc.	129
Hollandse Signaalapparaten, N. V.	144
Hunter Douglas Aluminum Corporation	145
Hydraulic Press Manufacturing Company	5
International Nickel Company	4
Kelsey-Hayes Wheel Company	111
King-Seeley Corporation	23
Kohler Company	106
Lehigh Chemical Company	118
LeTourneau, Inc., R. G.	120
Librascope, Inc.	182
Lurie Engineering Corporation	139
Magnetic Metals Company	78
Mallory-Sharon Titanium Corporation	112
Markem Machine Company	128
Marquardt Aircraft Company	14
Martin Company, Glenn L.	119
Mason & Hanger-Silas Mason Company	116
Metal Carbides Corporation	22
Minneapolis-Honeywell Regulator Company	166
Motoresearch Company	98
Motorola, Inc.	149
National Tube Division, U. S. Steel Corporation	124
New York Air Brake Company	25
Niagara Blower Company	164
Northern Ordnance, Incorporated	164
Oakite Products, Inc.	28
Oil Well Supply Division, U. S. Steel Corporation	162
Olin Mathieson Chemical Corporation	14
Oliver Corporation, A. B. Farquhar Division	136
Perkin-Elmer Corporation	18
Vernistat Division	82
Phillips Petroleum Company	15
Pioneer Engineering & Manufacturing Company	128
Pyle-National Company	92
Radio Corporation of America	97, 160
Raytheon Manufacturing Company	12
Reaction Motors, Inc.	14
Reeves Instrument Corporation	117
Remington Arms Company	96
Solar Aircraft Company	115
Sperry Gyroscope Company, Division Sperry Rand Corporation	83
Standard Tube Company	127
Surface Combustion Corporation	2
Temco, Inc.	138
Texas Instruments, Inc.	30
Thiokol Chemical Corporation	107
Timken Roller Bearing Company	II Cover
Tung-Sol Electric, Inc.	122
U. S. Hoffman Machinery Corporation	24
U. S. Industries, Inc.	91
Verson Allsteel Press Company	156
Vulcan Machine Company	88
Wallace Supplies Manufacturing Company	108
Waterbury Farrel Foundry & Machine Company	26
Whittaker Gyro, Inc.	104
Wirebound Box Manufacturers Association	99
Wolverine Tube Division, Calumet & Hecla, Inc.	29
Zenith Optical Laboratory	163

ORDNANCE *is set up, printed, and bound for the American Ordnance Association by the William Byrd Press, Inc., Richmond, Va.*



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VOLUME XLI, NO. 217 • SECTION II • JULY-AUGUST, 1956

ORDNANCE

LAND SEA AIR

The Annual Directory Section
1956-1957

CONTENTS

Members of Council, American Ordnance Association
Board of Directors and Executive Committee
National Officers and Advisory Board
Officers and Directors of All Local Posts
Members of the Technical Divisions and Committees
Organization Chart of the National Association
Honor Roll of Company Members

Published by the
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CONTENTS

	Page
The American Ordance Association	4
Members of Council	5
Board of Directors and Executive Committee	6
National Officers and Advisory Board	6
Officers and Directors of Local Posts	7
Special Liaison Committees of the A.O.A.	16
Members of Technical Divisions and Committees	17
Organization Chart of the National Association	26
Honor Roll of Company Members	38

AMERICAN ORDNANCE ASSOCIATION

Founded 1919

A patriotic, educational, scientific, nonpolitical, and nonprofit-making organization of American citizens dedicated to scientific and industrial preparedness for the common defense

ORDNANCE is the generic term embracing:

All weapons, armament, and appurtenances for their operation and maintenance, whether land-based, on or under the sea or airborne, including—

All ammunition and its chemical, metallurgical, and atomic components.

All rockets, bombs, guided missiles, torpedoes, depth charges, and mines.

All combat vehicles, tanks, tank destroyers, and weapon carriers.

All vehicles for automotive transport of personnel and matériel on land.

All optical, aërial, mechanical, electrical, and electronic systems for locating and tracking targets on land, at sea, and in the air.

- The need for a civilian association of private citizens to coöperate with the ordnance organizations of our Armed Forces arises from the fact that, in the United States, in accordance with traditional national policy, there is little or no private industry for the production of ordnance in time of peace. Yet in time of emergency, as our experience in two world wars so tragically proved, ordnance of superior quality and in great quantities must be available in a very minimum of time for the use of our Armed Forces in order to avoid incurring unnecessary expenditures of hundreds of millions of dollars and, infinitely more important, the sacrifice of hundreds of thousands of American lives.

- Trained scientists and engineers in the laboratories and industrial establishments of our country, alert executives and key men of our factories and plants, students at our technical colleges, and artisans of our vast economy—all are united through membership in the American Ordnance Association in the firm determination to achieve peace through strength by providing superior ordnance for our Armed Forces.

- To keep alive a knowledge of ordnance design and production; to assist in the solution of the ramified technical, scientific, and economic problems incident to ordnance preparedness; to weld into an active, alert, and skilled group all eligible citizens for the advancement of scientific and industrial preparedness, and thus to contribute to the strength of our national security and the maintenance of peace—these are the goals of the American Ordnance Association, and to these ends its constitution and by-laws are directed. An organization chart of the Association is on pages 26 and 27.

American Ordnance Association

COUNCIL

The elective body of the Association is its Council composed of one member representing each local Post, one member representing each Technical Division, the three immediate past presidents, the charter national officers and directors, and twenty-four members at large.

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Posts of the Association are formed for the general purpose of cultivating a more intimate understanding of ordnance subjects through meetings, plant visits, seminars, and reports on particular ordnance problems.

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Treasurer: Leslie D. Burtenshaw, Santa Fe Operations Office, AEC, Albuquerque, N. Mex.
Directors: C. H. Lembke, Lembke-Clough and King, Inc., Albuquerque, N. Mex.
C. W. Lytle, Lytle Engineering & Manufacturing Company, Albuquerque, N. Mex.
R. G. Otto, Edgar D. Otto and Son, Albuquerque, N. Mex.
A. E. Uehlinger, Santa Fe Operations Office, AEC, Albuquerque, N. Mex.
National Council Representative: C. F. H. Begg, Kirtland Air Force Base, Albuquerque, N. Mex.

Birmingham Post, December 3, 1930

President: William J. Rushton, Protective Life Insurance Company, Birmingham, Ala.
Vice-President: A. B. Schwarzkopf, U. S. Pipe and Foundry Company, Birmingham, Ala.
Treasurer: Robert D. Cotten, Clark-Cotten Mortgage Company, Birmingham, Ala.
Secretary: Ralph E. Parker, 8328 S. First Avenue, Birmingham, Ala.
Directors: Lindsey Bilder, Rudisill Foundry Company, Anniston, Ala.
Richard M. Donahue, Line Material Company, Birmingham, Ala.
R. C. Harris, Harris Foundry & Machine Company, Cordele, Ga.
Roy D. Hickman, Alabama Engraving Company, Birmingham, Ala.
Thomas E. Kilby, Jr., Kilby Steel Company, Anniston, Ala.
P. S. Knox, Jr., Knox Metal Products, Inc., Thompson, Ga.
K. V. McMasters, Sherwood Moore Iron Works, Birmingham, Ala.
Russell H. Pedigo, consulting engineer, Leland, Miss.
F. L. Pyle, Spencer Chemical Company, Vicksburg, Miss.
William J. Rushton, Protective Life Insurance Company, Birmingham, Ala.
Herbert E. Smith, Jr., Vulcan Rivet & Bolt Corporation, Birmingham, Ala.
Arthur V. Wiebel, Tennessee Coal and Iron Division, U. S. Steel Corporation, Fairfield, Ala.
National Council Representative: Warren Whitney, James B. Clow & Sons, Birmingham, Ala.

Huntsville Chapter, Birmingham Post

Chairman: J. A. Muller, Redstone Arsenal, Huntsville, Ala.
Vice-Chairmen: T. D. Johnson, North Alabama Associates, Decatur, Ala.
W. A. Lewis, Redstone Arsenal, Huntsville, Ala.
Secretary-Treasurer: J. D. Darwin, Redstone Arsenal, Huntsville, Ala.

Capital Cities Post, February 8, 1950

President: A. A. K. Booth, Rensselaer Polytechnic Institute, Troy, N. Y.
Vice-Presidents: Arthur B. Gregg, Jr., General Electric Company, Schenectady, N. Y.
E. S. Mathews, Watervliet Arsenal, Watervliet, N. Y.
Secretary-Treasurer: Raymond A. Currier, Watervliet Arsenal, Watervliet, N. Y.
Directors: Richard S. Arthur, General Electric Company, Schenectady, N. Y.
E. M. Ashworth, Lovejoy Patent Specialty Company, Hoosick Falls, N. Y.
A. A. K. Booth, Rensselaer Polytechnic Institute, Troy, N. Y.
V. D'Anza, Attorney General's Office, Albany, N. Y.
Albert Demont, General Electric Company, Pittsfield, Mass.
E. B. Doherty, National City Bank, Troy, N. Y.
Arthur B. Gregg, Jr., General Electric Company, Schenectady, N. Y.
W. A. Kitts, 3rd, General Electric Company, Schenectady, N. Y.
Malcolm S. MacKenzie, Behr-Manning Corporation, Troy, N. Y.
E. S. Mathews, Watervliet Arsenal, Watervliet, N. Y.
E. S. Webster, Watervliet Arsenal, Watervliet, N. Y.
John S. Wyld, New York Chamber of Commerce, Albany, N. Y.
National Council Representative: Harry L. Erlicher, General Electric Company, Schenectady, N. Y.

Chicago Post, May 3, 1924

President: Thomas Drever, American Steel Foundries, Chicago, Ill.
Vice-Presidents: James W. Karraker, Northern Trust Company, Chicago, Ill.
H. J. Prebensen, Air Comfort Corporation, Chicago, Ill.
W. G. Swartchild, Jr., Swartchild & Company, Chicago, Ill.
Treasurer: G. D. Dearlove, International Harvester Company, Chicago, Ill.
Secretary: E. J. O'Keefe, O'Keefe & Walters, 332 South Michigan Avenue, Chicago, Ill.
Directors: Marion J. Allen, American Steel Foundries, Chicago, Ill.

R. C. Archer, International Harvester Company, Chicago, Ill.
Mark Brown, Harris Trust & Savings Bank, Chicago, Ill.
John W. Browning, Joliet, Ill.
E. J. Bush, Diamond T Motor Car Company, Chicago, Ill.
E. S. Higginbotham, Tokheim Oil Tank & Pump Company, Fort Wayne, Ind.
Henry P. Isham, Clearing Industrial District, Inc., Chicago, Ill.
James S. Knowlson, Stewart-Warner Corporation, Chicago, Ill.
Charles Z. Meyer, First National Bank, Chicago, Ill.
Francis W. Parker, Jr., Parker & Carter, Chicago, Ill.
Keith Parsons, Milliken, Vollers & Parsons, Chicago, Ill.
J. Albert Roesch, Roesch & Crosby, Chicago, Ill.
Francis A. Seng, Seng Company, Chicago, Ill.
John Slezak, Kable Printing Company, Mount Morris, Ill.
National Council Representative: Marion J. Allen, American Steel Foundries, Chicago, Ill.

Cincinnati Post, December 10, 1925

President: Robert S. Gruver, Armco Steel Corporation, Middletown, Ohio.
Vice-Presidents: F. Donald Hart, Temco, Inc., Nashville, Tenn.
Henry V. Heuser, Henry Vogt Machine Company, Louisville, Ky.
Perrin G. March, III, Cincinnati Shaper Company, Cincinnati, Ohio.
Secretary-Treasurer: Lennard C. Sorensen, Cincinnati Ordnance District, Big Four Building, Cincinnati, Ohio.
Directors: Frederick V. Geier, Cincinnati Milling Machine Company, Cincinnati, Ohio.
Robert S. Gruver, Armco Steel Corporation, Middletown, Ohio.
Harvey C. Knowles, Procter & Gamble Company, Cincinnati, Ohio.
Harold R. LeBlond, Cleveland Automatic Machine Company, Cincinnati, Ohio.
Homer E. Lunken, Lunkenheimer Company, Cincinnati, Ohio.
Perrin G. March, III, Cincinnati Shaper Company, Cincinnati, Ohio.
David A. Meeker, Hobart Manufacturing Company, Troy, Ohio.
William H. Mitchell, Mitchell Steel Company, Cincinnati, Ohio.
E. B. Newill, Allison Division, General Motors Corporation, Indianapolis, Ind.
Louis Polk, Sheffield Corporation, Dayton, Ohio.
W. A. Rentschler, Baldwin-Lima-Hamilton Corporation, Hamilton Division, Hamilton, Ohio.
Harry S. Robinson, Cincinnati, Ohio.
National Council Representative: Perrin G. March, III, Cincinnati Shaper Company, Cincinnati, Ohio.

The Citadel Post, February 21, 1951

President: Cadet R. L. Tapp, The Citadel, Charleston, S. C.
First Vice-President: Cadet J. M. Tatum, The Citadel, Charleston, S. C.
Second Vice-President: Cadet C. F. Stewart, The Citadel, Charleston, S. C.
Secretary-Treasurer: Cadet R. H. Miller, The Citadel, Charleston, S. C.
Faculty Adviser: Capt. John E. Carr, III, Ordnance Corps, The Citadel, Charleston, S. C.

Cleveland Post, October 25, 1940

President: Albert J. Weatherhead, Jr., Weatherhead Company, Cleveland, Ohio.
Vice-President: J. E. Trainer, Firestone Tire & Rubber Company, Akron, Ohio.
Secretary-Treasurer: J. C. McHannan, Central National Bank of Cleveland, Cleveland, Ohio.
Executive Secretary: Seward Covert, Seward Covert & Associates, Cleveland, Ohio.
Directors: Robert F. Black, White Motor Company, Cleveland, Ohio.
Harold R. Boyer, Cleveland Cadillac Tank Plant, Cleveland, Ohio.
George C. Brainard, Addressograph-Multigraph Company, Euclid, Ohio.
Ward M. Canaday, Overland Corporation, Toledo, Ohio.
Fred H. Chapin, National Acme Company, Cleveland, Ohio.
B. W. Chidlaw, Thompson Products, Inc., Cleveland, Ohio.
Frederick C. Crawford, Thompson Products Company, Euclid, Ohio.
William H. Forster, Jr., Hayes Manufacturing Company, Erie, Pa.
Clyde T. Foster, Standard Oil Company, Cleveland, Ohio.
H. P. Ladds, National Screw & Manufacturing Company, Cleveland, Ohio.
W. G. Laffer, Clevite Corporation, Cleveland, Ohio.
Albert Miller, Central Ohio Paper Company, Columbus, Ohio.
Walter F. Munford, American Steel & Wire Company, Cleveland, Ohio.
C. I. Ochs, Eaton Manufacturing Company, Cleveland, Ohio.
William I. Ong, American Steel & Wire Company, Cleveland, Ohio.
T. F. Patton, Republic Steel Corporation, Cleveland, Ohio.
Hermon Safford, Ohio Rubber Company, Willoughby, Ohio.
A. W. Steudel, Sherwin-Williams Company, Cleveland, Ohio.
Charles J. Stilwell, Warner & Swasey Company, Cleveland, Ohio.
Edwin J. Thomas, Goodyear Tire & Rubber Company, Akron, Ohio.
W. Robert Timken, Timken Roller Bearing Company, Canton, Ohio.
E. F. Tomlinson, B. F. Goodrich Company, Akron, Ohio.
William A. Weaver, Griswold-Eshleman Company, Cleveland, Ohio.
Charles M. White, Republic Steel Corporation, Cleveland, Ohio.
Dr. Clyde W. Williams, Battelle Memorial Institute, Columbus, Ohio.
National Council Representative: A. J. Weatherhead, Jr., Weatherhead Company, Cleveland, Ohio.

Columbia River Post, June 14, 1950

President: G. E. Healy, Portland Gas & Coke Company, Portland, Oreg.
First Vice-President: Ralph McGilvra, Product Engineering Company, Portland, Oreg.
Second Vice-President: William C. Schmitt, Schmitt Steel Inc., Portland, Oreg.
Treasurer: Delmar C. Wise, Morris P. Kirk & Son, Inc., Portland, Oreg.
Secretary: John R. Anderson, Carborundum Company, Vancouver, Wash.
Directors: James D. Barnes, Calder Buick Company, Gladstone, Oreg.
James R. Geddes, Master Manufacturing & Development Company, Oak Grove, Oreg.
H. R. Hopkins, Sidney Boots Realty, Portland, Oreg.
H. T. Lowry, Iron Fireman Manufacturing Company, Portland, Oreg.
A. F. McGarr, Lomac Motors, Inc., Portland, Oreg.
Jesse M. Roseberry, Instrument Sales & Service, Portland, Oreg.
A. B. Smith, Smith Chevrolet Company, Portland, Oreg.
National Council Representative: William P. Allyn, U. S. National Bank, Portland, Oreg.

Empire Post, April 29, 1938

President: Ralph F. Peo, Houdaille Industries, Inc., Buffalo, N. Y.
First Vice-President: Claude G. Wright, Page Airways, Inc., Rochester, N. Y.
Second Vice-President: John H. Bouman, Ansco Division, General Aniline & Film Corporation, Binghamton, N. Y.
Treasurer: Raymond M. Biehler, Rochester Institute of Technology, Rochester, N. Y.
Secretary: W. A. Davis, Rochester Ordnance District, Rochester, N. Y.
Assistant Secretary: Ethel E. Henschel, Rochester Ordnance District, Rochester, N. Y.
Directors: George R. Auld, Carrier Corporation, Syracuse, N. Y.
Alexander M. Beebee, Rochester Gas & Electric Corporation, Rochester, N. Y.
John H. Bouman, Ansco Division, General Aniline & Film Corporation, Binghamton, N. Y.
Robert E. Dillon, Lake Erie Engineering Corporation, Buffalo, N. Y.
Mark Ellingson, Rochester Institute of Technology, Rochester, N. Y.
Leston P. Faneuf, Bell Aircraft Corporation, Buffalo, N. Y.
Philip P. Glassey, Syracuse Industries Division, Union Chemical & Materials Corporation, Syracuse, N. Y.
Carl S. Hallauer, Bausch & Lomb Optical Company, Rochester, N. Y.
Fred F. Hickey, Savage Arms Corporation, Utica, N. Y.
H. Follett Hodgkins, Lipe-Rollway Company, Inc., Syracuse, N. Y.
R. A. Lenna, Blackstone Corporation, Jamestown, N. Y.
Ray C. Malvin, Houdaille Industries, Inc., Buffalo, N. Y.
James E. McGhee, Eastman Kodak Company, Rochester, N. Y.
Charles F. Mosher, Rochester Ordnance District, Rochester, N. Y.
John J. O'Neil, Cornell Aëronautical Laboratory, Inc., Buffalo, N. Y.
Ralph F. Peo, Houdaille Industries, Inc., Buffalo, N. Y.
Lyman K. Stuart, C. H. Stuart & Company, Newark, N. Y.
Lewis B. Swift, Taylor Instrument Company, Rochester, N. Y.
National Council Representative: E. Gwyn Thomas, Manufacturers Association of Syracuse, Syracuse, N. Y.

Frontier Chapter, Empire Post

Chairman: John J. O'Neil, Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y.
Membership Committee: Ray C. Neal, R. C. Neal Company, Buffalo, N. Y.
Treasurer: Walter Schmidt, Niagara Mohawk Power & Light Company, Niagara Falls, N. Y.

Jamestown Chapter, Empire Post

Chairman: C. Earl Norquist, Norquist Products, Inc., Jamestown, N. Y.

Mohawk Valley Chapter, Empire Post

Chairman: Francis R. Gorman, Gorman & Halpern, Utica, N. Y.
Vice-Chairman: Thomas Bright, Revere Copper & Brass Company, Rome, N. Y.

Rochester Chapter, Empire Post

Chairman: Ray M. Biehler, Rochester Institute of Technology, Rochester, N. Y.
Vice-Chairman: Earl T. Gruendike, General Railway Signal Company, Rochester, N. Y.

Southern Tier Chapter, Empire Post

Chairman: Claude Wright, Page Airways, Inc., Rochester, N. Y.
Secretary: F. N. Tracy, Ward LaFrance Truck Corporation, Elmira, N. Y.

Syracuse-Central New York Chapter, Empire Post

Chairman: Tom C. Rives, Technical Military Relations Electronics Division, General Electric Company, Syracuse, N. Y.
First Vice-Chairman: William J. During, Precision Castings Company, Syracuse, N. Y.
Second Vice-Chairman: Gustav F. Watters, Niagara Mohawk Power Corporation, Syracuse, N. Y.
Vice-Chairmen: George R. Auld, Carrier Corporation, Syracuse, N. Y.
Fred N. Claypole, Syracuse, N. Y.
William A. Gabrielson, Smith-Corona, Inc., Syracuse, N. Y.
J. F. Kerigan, New Process Gear Corporation, Syracuse, N. Y.
George Lilygren, Carrier Corporation, Syracuse, N. Y.
V. M. Lucas, General Electric Company, Syracuse, N. Y.
Harry C. Marley, Syracuse Surplus Company, Syracuse, N. Y.
R. P. McClure, Precision Castings Company, Syracuse, N. Y.
C. D. Osborne, *Auburn Citizen-Advertiser,* Auburn, N. Y.
Clifford Palmer, Cleveland Container Company, Ogdensburg, N. Y.
Jay R. Petree, Crouse-Hinds Company, Syracuse, N. Y.
Conan A. Priest, Onondaga Pottery Company, Syracuse, N. Y.
Mark Russell, Pass & Seymour, Inc., Syracuse, N. Y.
Edwin R. Tharp, Syracuse Industries Division, Union Chemical & Materials Corporation, Syracuse, N. Y.
Secretary: E. Gwyn Thomas, Manufacturers Association of Syracuse, Syracuse, N. Y.

Tri-Cities Chapter, Empire Post

Chairman: John H. Bouman, Ansco Division, General Aniline & Film Corporation, Binghamton, N. Y.
Vice-Chairmen: J. P. Dickinson, Stow Manufacturing Company, Binghamton, N. Y.
B. W. Elliott, Elliott Manufacturing Company, Binghamton, N. Y.
C. H. Thompson, Thompson Company, Binghamton, N. Y.
Secretary: W. A. Kinnaman, General Electric Company, Johnson City, N. Y.
Treasurer: I. H. Lohman, International Business Machines Corporation, Endicott, N. Y.

Florida Post, June 12, 1951

President: Henry B. Kucheman, Air Force Armament Center, Eglin Air Force Base, Fla.
First Vice-President: Edward W. Clarno, Eglin Air Force Base, Fla.
Second Vice-President: Alf T. Clausen, Eglin Air Force Base, Fla.
Secretary: Robert L. Reeder, Eglin Air Force Base, Fla.
Corresponding Secretary: W. F. Spence, Air Force Armament Center, Eglin Air Force Base, Fla.
Treasurer: Andrew J. Erickson, Vitro Corporation of America, Eglin Air Force Base, Fla.
Directors: The officers and Kenneth E. Brown, Eglin Air Force Base, Fla.
Michael E. Cassese, Eglin Air Force Base, Fla.
Kenneth F. Fulton, Hurlburt Air Force Base, Fla.
Joe E. Heatherly, Eglin Air Force Base, Fla.
James W. Heyroth, Eglin Air Force Base, Fla.
Jan M. Laitos, Eglin Air Force Base, Fla.
Horace W. Lanford, Jr., Eglin Air Force Base, Fla.
Charles G. Mettler, Miami Beach, Fla.
G. W. Mitchell, Valparaiso, Fla.

John J. Murphy, Ft. Walton, Fla.
William R. Stark, Shalimar, Fla.
National Council Representative: Edward P. Mechling, Eglin Air Force Base, Fla.

Hartford-Springfield Post, November 18, 1941

President: S. C. Hope, Esso Standard Oil Company, New York, N. Y.
Vice-Presidents: J. H. Chaplin, Veeder-Root, Inc., Hartford, Conn.
C. H. Granger, Waterbury, Conn.
Secretary-Treasurer: J. A. MacDonnell, Gilbert & Barker Manufacturing Company, West Springfield, Mass.
Directors: F. H. Payne, Springfield, Mass., *chairman;* the officers and
G. H. Anthony, Colt's Patent Fire Arms Manufacturing Company, Hartford, Conn.
J. S. Begley, Holyoke, Mass.
William J. Crowe, Longmeadow, Mass.
C. K. Davis, Remington Arms Company, Bridgeport, Conn.
G. H. Drewry, Niles-Bement-Pond Company, West Hartford, Conn.
M. L. Driscoll, Springfield Ordnance District, Springfield, Mass.
W. M. Goss, Scovill Manufacturing Company, Waterbury, Conn.
James L. Guion, Springfield, Mass.
C. R. Hellstrom, Smith & Wesson, Inc., Springfield, Mass.
D. P. Hess, American Bosch Arma Corporation, Springfield, Mass.
D. G. Ludlam, Springfield Armory, Springfield, Mass.
D. G. Millar, Greenfield Tap and Die Corporation, Greenfield, Mass.
H. H. Pease, New Britain Machine Company, New Britain, Conn.
R. E. Pritchard, Stanley Works, New Britain, Conn.
E. S. Pugsley, New Haven, Conn.
James Y. Scott, Van Norman Company, Springfield, Mass.
H. W. Steinkraus, Bridgeport Brass Company, Bridgeport, Conn.
James R. Weaver, Westinghouse Electric Corporation, Springfield, Mass.
National Council Representative: J. H. Chaplin, Veeder-Root, Inc., Hartford, Conn.

Lone Star Post, June 12, 1945

President: I. Nevin Palley, Temco Aircraft Corporation, Dallas, Tex.
First Vice-President: F. B. McKimball, Southwest Gauge Company, Dallas, Tex.
Second Vice-President: Homer Dunn, Hardwick-Etter Company, Sherman, Tex.
Secretary-Treasurer: L. A. Childs, Jr., Temco Aircraft Corporation, Box 6191, Dallas 2, Tex.
Directors: R. C. Blaylock, Chance Vought Aircraft Company, Dallas, Tex.
F. W. Davis, Convair Division, General Dynamics Corporation, Fort Worth, Tex.
C. A. Fischer, Harbison-Fischer Company, Fort Worth, Tex.
C. V. Fletcher, Dallas, Tex.
H. F. Haslbauer, Continental Gin Company, Dallas, Tex.
A. M. Kahan, Texas Agricultural & Mechanical College, College Station, Tex.
F. L. LeBus, LeBus Rotary Tool Works, Inc., Longview, Tex.
Forbes Mann, Chance Vought Aircraft Company, Dallas, Tex.
R. H. Norris, Dearborn Stove Company, Dallas, Tex.
W. W. Wells, Big 3 Welding Supply, Fort Worth, Tex.
National Council Representative: H. R. Jordan, Chance Vought Aircraft Company, Dallas, Tex.

Los Angeles Post, May 27, 1936

President: R. C. Geffs, Clary Corporation, San Gabriel, Calif.
First Vice-President: F. W. Conant, Douglas Aircraft Company, Santa Monica, Calif.
Second Vice-President: W. S. Broberg, Los Angeles, Calif.
Treasurer: Samuel K. Rindge, Citizens National Bank, Los Angeles, Calif.
Secretary: Robert W. Reniers, Standard Coil Products Company, 1919 Vineburn Avenue, Los Angeles 32, Calif.
Directors: The officers and T. T. Arden, Grayson Controls Division, Robertshaw-Fulton Controls Company, Lynwood, Calif.
Aubrey E. Austin, Jr., Santa Monica Commercial Trust & Savings Bank, Santa Monica, Calif.
B. A. Bannan, Western Gear Works, Lynwood, Calif.
Omar N. Bradley, Aerojet-General Corporation, Los Angeles, Calif.
Henry L. Clark, Los Angeles, Calif.
Whitley C. Collins, Northrop Aircraft Company, Hawthorne, Calif.
Gordon B. Crary, Jr., E. F. Hutton & Company, Los Angeles, Calif.
Louis G. Dunn, Pacific Palisades, Calif.
Homer O. Eaton, 40th Armored Division, California National Guard, Los Angeles, Calif.
Leonard K. Firestone, Firestone Tire & Rubber Company, Los Angeles, Calif.
C. C. Gabrielson—Gabrielson, O'Sullivan, Poulson & Company, Los Angeles, Calif.
H. L. Hoffman, Hoffman Laboratories, Inc., Los Angeles, Calif.
Earle M. Jorgenson, Earle M. Jorgenson Steel Company, Los Angeles, Calif.
Robert T. Keller, Chrysler Corporation, Los Angeles, Calif.
P. W. Lizza, Bermite Powder Company, Saugus, Calif.
W. B. McGee, Hughes Aircraft Company, Culver City, Calif.
K. T. Norris, Norris-Thermador Corporation, Los Angeles, Calif.
Robert Q. Parsons, Century Engineers, Inc., Burbank, Calif.
Morris Pendleton, Plomb Tool Company, Los Angeles, Calif.
John B. Rauen, United States Spring and Bumper Company, Los Angeles, Calif.
L. J. Soracco, Bethlehem Pacific Coast Steel Corporation, Los Angeles, Calif.
John D. Spalding, National Supply Company, Torrance, Calif.
W. A. Wilson, Web Wilson Oil Tools, Inc., Los Angeles, Calif.
W. E. Zander, Rheem Manufacturing Company, South Gate, Calif.
W. E. Zisch, Aerojet-General Corporation, Azusa, Calif.
National Council Representative: Earle M. Jorgenson, Earle M. Jorgenson Steel Company, Los Angeles, Calif.

China Lake Chapter, Los Angeles Post

Chairman: A. S. Gould, Naval Ordnance Test Station, China Lake, Calif.
Vice-Chairman: J. L. Cox, Naval Ordnance Test Station, China Lake, Calif.
Assistant Chairman: F. J. Lavacot, Naval Ordnance Test Station, China Lake, Calif.
Assistant Chairman: Donald Trewhella, Naval Ordnance Test Station, China Lake, Calif.

Louisiana Post, May 24, 1950

President: James A. Ward, Louisiana Ordnance Plant, Shreveport, La.
Vice-Presidents: Otto M. Jank, Lone Star Ordnance Plant, Texarkana, Tex.
Frank Kelly, Jr., Arkansas Louisiana Gas Company, Shreveport, La.

Treasurer: Ernest A. Merklein, Jr., Merklein and Company, Shreveport, La.
Secretary: Hubert E. Evans, Louisiana Ordnance Plant, Shreveport, La.
Directors: Richard B. Bailey, Louisiana Power & Light Company, Monroe, La.
C. L. Bernard, Cleveland Diesel Engine Division, GMC, New Orleans, La.
C. L. Brockschmidt, Texas Eastern Transmission Corporation, Shreveport, La.
W. R. Ignatius, Longhorn Ordnance Works, Marshall, Tex.
Jack W. Marston, Louisiana Ordnance Plant, Shreveport, La.
W. G. Martin, Naval Ammunition Depot, Shumaker, Ark.
Ernest Merklein, Sr., Merklein and Company, Shreveport, La.
J. G. O'Brien, J. B. Beaird Company, Shreveport, La.
Frank Paley, Longhorn Ordnance Works, Marshall, Tex.
National Council Representative: Ernest A. Merklein, Sr., Merklein and Company, Shreveport, La.

New Orleans Chapter, Louisiana Post

President: Willard L. Love, Rheem Manufacturing Company, New Orleans, La.
Vice-President: R. A. Murphy, Jr., Higgins, Inc., New Orleans, La.
Secretary: H. A. Long, Rheem Manufacturing Company, New Orleans, La.
Treasurer: J. G. Hill, Jr., Whitney National Bank, New Orleans, La.

Massachusetts Institute of Technology Post, January 20, 1922

President: Chris K. Van Peski, Cambridge, Mass.
Vice-President: Morrin Hazel, Cambridge, Mass.
Treasurer: John Watts, Cambridge, Mass.
Secretary: Julio B. Arroyo, Jr., Baker House, M.I.T., Cambridge, Mass.
Directors: Joseph Goodwill, Boston, Mass.
William McNulty, Cambridge, Mass.
Robert Siegel, Cambridge, Mass.
Faculty Adviser: Lieut. Col. William Mattis, Ordnance Corps, R.O.T.C. Ordnance Detachment, Massachusetts Institute of Technology, Cambridge, Mass.

Michigan Post, December 12, 1942

President: Herbert R. White, Eclipse Counterbore Company, Detroit, Mich.
First Vice-President: Del S. Harder, Ford Motor Company, Dearborn, Mich.
Second Vice-President: G. B. Bonfield, American Box Board Company, Grand Rapids, Mich.
Secretary-Treasurer: Charles W. Brownell, National Bank of Detroit, Detroit, Mich.
Directors: G. B. Bonfield, American Box Board Company, Grand Rapids, Mich.
Thomas Couper, L. A. Young Spring & Wire Corporation, Detroit, Mich.
Raymond R. Eppert, Burroughs Corporation, Detroit, Mich.
J. Frank Forster, Vickers, Inc., Detroit, Mich.
Britton L. Gordon, Blackmer Pump Company, Grand Rapids, Mich.
Elisha Gray, II, Whirlpool-Seeger Corporation, St. Joseph, Mich.
Del S. Harder, Ford Motor Company, Dearborn, Mich.
George M. Holley, Jr., Holley Carburetor Company, Van Dyke, Mich.
V. H. Kendall, Universal Products Company, Dearborn, Mich.
P. J. Monaghan, General Motors Truck and Coach Division, GMC, Pontiac, Mich.
Thomas F. Morrow, Chrysler Corporation, Highland Park, Mich.
Louis E. Moultane, McLouth Steel Corporation, Detroit, Mich.
Fred W. Parker, Jr., Timken-Detroit Axle Division, Rockwell Spring and Axle Company, Detroit, Mich.
Henry Tuttle, Michigan Consolidated Gas Company, Detroit, Mich.
Herbert R. White, Eclipse Counterbore Company, Ferndale, Mich.
National Council Representative: James K. Fulks, Ex-Cell-O Corporation, Detroit, Mich.

Lansing Chapter, Michigan Post

President: Lester F. Carlson, Oldsmobile Division, GMC, Lansing, Mich.
Directors: Barney C. Cox, Melling Forging Company, Lansing, Mich.
Fredrik Marin, Bank of Lansing, Lansing, Mich.
Clarence A. Trump, Fisher Body Division, GMC, Lansing, Mich.

Western Michigan Chapter, Michigan Post

President: Elisha Gray, II, Whirlpool Corporation, St. Joseph, Mich.
Vice-President: S. K. Harrington, Kalamazoo Manufacturing Company, Kalamazoo, Mich.
Secretary: Britton L. Gordon, Blackmer Pump Company, Grand Rapids, Mich.
Directors: Gordon B. Bonfield, American Box Board Company, Grand Rapids, Mich.
A. H. Frauenthal, Kaydon Engineering Corporation, Muskegon, Mich.
Elisha Gray, II, Whirlpool Corporation, St. Joseph, Mich.
Andrew F. Haiduck, Lear, Inc., Grand Rapids, Mich.
S. K. Harrington, Kalamazoo Manufacturing Company, Kalamazoo, Mich.
Don R. Mitchell, Mitchell-Bentley Corporation, Ionia, Mich.

Mid-Continent Post, December 12, 1944

President: (to be elected)
Vice-President: R. R. King, American Body & Trailer Company, Oklahoma City, Okla.
Consulting Engineer: W. H. Stueve, Oklahoma City, Okla.
Secretary-Treasurer: C. R. Horton, Horton Engineering Company, 8211 E. Seventh Street, Tulsa, Okla.
Directors: Frank Hinderliter, Tulsa, Okla.
George Nicholson, Tulsa, Okla.
Walter O'Bannon, Jr., Walter O'Bannon Company, Tulsa, Okla.
Ed Warmack, Warmack Stove Company, Fort Smith, Ark.
National Council Representative: R. R. King, American Body and Trailer Company, Oklahoma City, Okla.

Midwest Post, May 16, 1945

President: Harry Darby, Darby Corporation, Kansas City, Kans.
Vice-President: C. M. Standiford, Kansas City, Kans.
Secretary-Treasurer: Fred B. Nichols, Sun Life Assurance Company of Canada, Kansas City, Mo.
Directors: Leroy M. Alexander, Sheffield Steel Corporation, Kansas City, Mo.
Paul Froeschl, Wilde Drop Forge & Tool Company, Kansas City, Mo.
Elmer Pierson, Vendo Company, Kansas City, Mo.
Kenneth Spencer, Spencer Chemical Company, Kansas City, Mo.
National Council Representative: Harry Darby, Darby Corporation, Kansas City, Kans.

Milwaukee Post, September 26, 1928

President: Jacobus Kruyne, Home Savings Bank, Milwaukee, Wis.
Vice-President: W. C. Messinger, Chain Belt Company, Milwaukee, Wis.
Secretary-Treasurer: (to be elected)
Directors: P. H. Batten, Twin-Disk Clutch Company, Racine, Wis.
Leon R. Clausen, J. I. Case Company, Racine, Wis.
W. W. Coleman, Bucyrus-Erie Company, South Milwaukee, Wis.
J. E. De Long, Waukesha Motors Corporation, Waukesha, Wis.
Harold S. Falk, Falk Corporation, Milwaukee, Wis.
Frederick D. Hansen, Evans-Hansen, Milwaukee, Wis.
W. C. Heath, A. O. Smith Corporation, Milwaukee, Wis.
H. Stanley Johnson, Jr., Gisholt Machine Company, Madison, Wis.
Herbert V. Kohler, Kohler Company, Kohler, Wis.
J. Clifford Merwin, Chain Belt Company, Milwaukee, Wis.
W. C. Messinger, Chain Belt Company, Milwaukee, Wis.
W. G. Prasse, Oilgear Company, Milwaukee, Wis.
Robert A. Uihlein, Jos. Schlitz Brewing Company, Milwaukee, Wis.
Pierpont J. E. Wood—Jeffres, Mouat, Oestreich, Wood & Cunningham, Janesville, Wis.
National Council Representative: Jacobus Kruyne, Home Savings Bank, Milwaukee, Wis.

Nebraska Post, June 22, 1944

President: Dana C. Bradford, Bradford-Kennedy Company, Omaha, Nebr.
Vice-President: Robert Bernstein, Independent Metals Company, Omaha, Nebr.
Secretary-Treasurer: Fred G. Arkoosh, Wilkinson Manufacturing Company, P. O. Box 127, Florence Station 12, Omaha, Nebr.
Directors: Robert Ammon, Cushman Motor Works, Inc., Lincoln, Nebr.
Frederick Bucholz, Omaha Steel Works, Omaha, Nebr.
Clyde B. Dempster, Dempster Mill Manufacturing Company, Beatrice, Nebr.
Burr Hughes, Hughes Brothers, Seward, Nebr.
Karl Vogel, State Senator, Omaha, Nebr.
Keith Waugh, Meade Ordnance Plant, Wahoo, Nebr.
National Council Representative: Dana C. Bradford, Bradford-Kennedy Company, Omaha, Nebr.

New York Post, June 15, 1921

President: Leslie R. Groves, Remington Rand Inc., New York, N. Y.
Vice-Presidents: Hartley W. Barclay, *New York Times,* New York, N. Y.
Howard E. Isham, United States Steel Corporation, New York, N. Y.
Chester Mueller, attorney at law, Newark, N. J.
A. E. Van Cleve, Barium Steel Corporation, New York, N. Y.
Secretary-Treasurer: J. W. Graham, New York Ordnance District, 180 Varick Street, New York 14, N. Y.
Directors: Nelson Anderson, Eastern Tool & Manufacturing Company, Belleville, N. J.
Joseph L. Auer, R. Hoe & Co., Inc., New York, N. Y.
John D. Dale, George H. Elliott & Company, New York, N. Y.
Arnold Erlanger, U. S. Hoffman Machinery Corporation, New York, N. Y.
George O. Kuhlke, management and business consultant, Westbury, L. I., N. Y.
Fred R. Lack, Radio Division, Western Electric Company, New York, N. Y.
Henry T. Luria, Luria Steel & Trading Corporation, New York, N. Y.
John I. McInerney, Manufacturers' Trust Company, New York, N. Y.
William L. O'Donovan, Celanese Corporation of America, New York, N. Y.
Martin M. Psaty, Greater New York Waterproofing Company, New York, N. Y.
Willis R. Slaughter, W. L. Maxson Corporation, New York, N. Y.
George S. Starke, Sperry Gyroscope Company, Division of Sperry-Rand Corporation, Great Neck, N. Y.
Gordon B. Welch, Mergenthaler Linotype Company, Brooklyn, N. Y.
National Council Representative: E. F. McCrossin, McCrossin & Company, New York, N. Y.

Northwest Post, March 15, 1945

President: W. C. MacFarlane, Sr., Minneapolis-Moline Company, Minneapolis, Minn.
First Vice-President: Harold W. Sweatt, Minneapolis-Honeywell Regulator Company, Minneapolis, Minn.
Second Vice-President: Charles L. Horn, Federal Cartridge Corporation, Minneapolis, Minn.
Secretary-Treasurer: Roland F. Wilson, 436 Palace Building, Minneapolis 1, Minn.
Directors: The officers and Albert P. Baston, Baston Motor Company, St. Cloud, Minn.
Fred Blumers, General Mills, Inc., Minneapolis, Minn.
P. G. Bourne, Seeger Refrigerator Company, St. Paul, Minn.
Charles E. Buckbee, Buckbee Mears Company, St. Paul, Minn.
Harry A. Bullis, General Mills, Inc., Minneapolis, Minn.
Walter F. Kasper, Fairmont Railway Motors, Inc., Fairmont, Minn.
Warren C. MacFarlane, Jr., Minneapolis-Moline Company, Minneapolis, Minn.
David W. Onan, D. W. Onan & Sons, Inc., Minneapolis, Minn.
George H. Rozum, Rozum Brothers Motors Company, Watertown, S. Dak.
Walter G. Seeger, Seeger Refrigerator Company, St. Paul, Minn.
Donald A. Smith, Smith, Inc., Fargo, N. Dak.
Alton V. Stallard, San Francisco, Calif.
Frank B. Winston, Winston Brothers Company, Minneapolis, Minn.
National Council Representative: W. C. MacFarlane, Sr., Minneapolis-Moline Company, Minneapolis, Minn.

Philadelphia Post, December 9, 1926

President: Everett B. Webster, Crown Cork & Seal Company, Philadelphia, Pa.
Vice-Presidents: Arthur J. Seiler, Gates Engineering Company, Wilmington, Del.
William P. Drake, Pennsylvania Salt Manufacturing Company, Philadelphia, Pa.
H. Paul Gant, Glen Moore, Pa.
Arthur B. Sinkler, Hamilton Watch Company, Lancaster, Pa.
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Directors: Robert H. Andrews, Vanity Fair Mills, Inc., Reading, Pa.
Edward G. Budd, Jr., Budd Company, Philadelphia, Pa.
George J. Burnham, United States Steel Corporation, Philadelphia, Pa.
Henry F. Dever, Brown Instrument Division, Minneapolis-Honeywell Regulator Company, Philadelphia, Pa.
Joseph H. Gillies, Philco Corporation, Philadelphia, Pa.
Albert W. Gilmer—Barnes, Dechert, Price, Myers & Rhoads, Philadelphia, Pa.
Vincent deP. Goubeau, Radio Corporation of America, Camden, N. J.
David N. Hauseman, Davison Chemical Company, Division of W. R. Grace & Company, Baltimore, Md.

J. G. Heckscher, Budd Company, Philadelphia, Pa.
C. Jared Ingersoll, Muskogee Company, Philadelphia, Pa.
McClure Kelly, Baldwin-Lima-Hamilton Corporation, Philadelphia, Pa.
Horace C. Knerr, Metlab Company, Inc., Philadelphia, Pa.
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Stewart E. Lauer, York Corporation, York, Pa.
Henry N. Marsh, Hercules Powder Company, Wilmington, Del. (*on leave with Department of the Army*)
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Howard C. Petersen, Fidelity-Philadelphia Trust Company, Philadelphia, Pa.
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J. T. Simpson, Harrisburg Steel Corporation, Harrisburg, Pa.
M. J. Warnock, Armstrong Cork Company, Lancaster, Pa.
Barclay White, Barclay White Company, Philadelphia, Pa.
William H. Worrilow, Sr., Lebanon Steel Foundry, Lebanon, Pa.
National Council Representative: William H. Worrilow, Sr., Lebanon Steel Foundry, Lebanon, Pa.

Lehigh University Chapter, Philadelphia Post

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Pittsburgh Post, Feburary 24, 1927

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Secretary: William S. Rial, Jr., Morrison Rubber Company, 1324 Highland Building, Pittsburgh, Pa.
Directors: The officers and John A. Appleton, Pennsylvania Railroad Company, Pittsburgh, Pa.
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Frank R. Denton, Mellon National Bank & Trust Company, Pittsburgh, Pa.
Robert C. Downie, Peoples First National Bank & Trust Company, Pittsburgh, Pa.
Fred C. Foy, Koppers Company, Pittsburgh, Pa.
Harry B. Higgins, Pittsburgh Plate Glass Company, Pittsburgh, Pa.
Lorenz Iversen, Mesta Machine Company, West Homestead, Pa.
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National Council Representative: Thomas H. Eddy, George A. Kelly Company, Pittsburgh, Pa.

Puget Sound Post, January 25, 1944

President: Marmion D. Mills, Winslow, Wash.
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Herbert J. Dobb, Jr., Western Gear Works, Seattle, Wash.
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C. Walter Huffine, C. Walter Huffine Agency, Seattle, Wash.
W. T. Jenkins, U. S. Naval Base, Bremerton, Wash.
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Ferdinand Schmitz, Jr., Berger Engineering Company, Seattle, Wash.
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Leon E. Titus, Titus Motor Company, Tacoma, Wash.
Walter Toly, Columbia Electric Manufacturing Company, Spokane, Wash.
John H. VanderVeer, Jr., Sperry Gyroscope Company, Seattle, Wash.
M. J. Williams, San Francisco Ordnance District, Seattle, Wash.
Lysle A. Wood, Boeing Airplane Company, Seattle, Wash.
National Council Representative: Marmion D. Mills, Winslow, Wash.

Quad Cities-Iowa Post, May 28, 1945

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A. R. Cyr, Rock Island Arsenal, Rock Island, Ill.
N. L. Etten, Chamberlain Corporation, Waterloo, Iowa.
Fred C. Glass, Ordnance Weapons Command, Rock Island, Ill.
Robert L. Harvey, Maytag Company, Newton, Iowa.
Ward L. Hunt, Dexter Division, Philco Corporation, Fairfield, Iowa.
H. K. Krumel, Solar Aircraft Company, Des Moines, Iowa.
Alex Matheson, French & Hecht Division, Kelsey-Hayes Wheel Company, Davenport, Iowa.
P. S. Mumford, John Deere Wagon Works, Moline, Ill.
John P. Murphy, International Harvester Company, East Moline, Ill.
John D. Nyquist, Collins Radio Company, Cedar Rapids, Iowa.

W. A. Sheaffer, II, W. A. Sheaffer Pen Company, Fort Madison, Iowa.
National Council Representative: Maurice A. Fraher, Deere & Company, Moline, Ill.

Rio Grande Post, November 6, 1952

President: W. E. Laidlaw, White Sands Proving Ground, N. Mex.
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Rupert Chisholm, Atlas Lumber Company, Las Cruces, N. Mex.
Howard Coleman, White Sands Proving Ground, N. Mex.
H. L. Karsh, White Sands Proving Ground, N. Mex.
Secretary: R. D. Worthen, White Sands Proving Ground, N. Mex.
Treasurer: Willis H. Clark, White Sands Proving Ground, N. Mex.
Directors: A. P. Alexander, Fort Bliss, Tex.
R. W. Benfer, Western Electric Company, White Sands Proving Ground, N. Mex.
F. M. Bowman, Banner Mining Company, Lordsburg, N. Mex.
W. H. Clohessy, White Sands Proving Ground, N. Mex.
J. P. Hamill, White Sands Proving Ground, N. Mex.
B. J. L. Hirshorn, White Sands Proving Ground, N. Mex.
S. G. Horne, Jr., Roswell, N. Mex.
R. H. Kyckelhahn, White Sands Proving Ground, N. Mex.
F. D. Mayes, White Sands Proving Ground, N. Mex.
National Council Representative: Henry E. Minton, El Paso, Tex.

Rocky Mountain Post, June 10, 1942

President: Harold F. Silver, Silver Engineering Works, Inc., Denver, Colo.
Vice-President: James Colasanti, Metal Treating & Research Company, Denver, Colo.
Secretary-Treasurer: J. R. Caten, Rocky Mountain Division, Colorado Fuel & Iron Corporation, 4950 Colorado Boulevard, Denver, Colo.
Directors: Arch Browning, Salt Lake City, Utah.
C. C. Drake, Griffin Wheel Company, Denver, Colo.
Fred R. Eberhardt, Eberhardt-Denver Company, Denver, Colo.
Benjamin C. Essig, Gardner-Denver Company, Denver, Colo.
J. K. Garretson, Republic Steel Corporation, Denver, Colo.
John G. Gates, Gates Rubber Company, Denver, Colo.
Robert P. Gutshall, Colorado Tent & Awning Company, Denver, Colo.
W. R. Heckethorn, Heckethorn Manufacturing & Supply Company, Littleton, Colo.
J. J. Martin, Colorado Fuel & Iron Corporation, Pueblo, Colo.
C. Neil Norgren, C. A. Norgren Company, Denver, Colo.
William M. Reno, Bill Reno, Inc., Denver, Colo.
Gerould A. Sabin, Colorado Fuel & Iron Corporation, Denver, Colo.
Stanley C. Shubart, Schloss & Shubart, Denver, Colo.
C. W. Webb, Armco Drainage & Metal Products Company, Denver, Colo.
Adolph D. Weiss, Winter-Weiss Company, Denver, Colo.
National Council Representative: James D. Maitland, Cobusco Steel Products, Denver, Colo.

St. Louis Post, January 18, 1927

President: L. J. Sverdrup, Sverdrup & Parcel, Inc., St. Louis, Mo.
Vice-President: George W. Brown, Wagner Electric Corporation, St. Louis, Mo.
Treasurer: T. O'Truk, St. Louis Air Procurement District, St. Louis, Mo.
Secretary: G. F. Hanssen, St. Louis Ordnance District, 1016 Olive Street, St. Louis 1, Mo.
Directors: B. E. Bassett, Olin Mathieson Chemical Corporation, East Alton, Ill.
P. G. Dolan, St. Louis Air Procurement District, St. Louis, Mo.
W. A. Evans, St. Louis Ordnance District, St. Louis, Mo.
Aaron Fischer, Universal Match Corporation, St. Louis, Mo.
W. P. Gatley, National Rejectors, Inc., St. Louis, Mo.
I. L. Jerger, St. Louis Ordnance District, St. Louis, Mo.
J. Wesley McAfee, Union Electric Company, St. Louis, Mo.
C. L. Miller, U. S. Naval Air Station, St. Louis, Mo.
W. A. Morse, St. Louis Ordnance District, St. Louis, Mo.
A. J. Mummert, McQuay-Norris Manufacturing Company, St. Louis, Mo.
W. R. Persons, Emerson Electric Manufacturing Company, St. Louis, Mo.
M. F. Peterson, Carter Carburetor Corporation, St. Louis, Mo.
T. W. Pettus, Scullin Steel Company, St. Louis, Mo.
Vincent P. Ring, Knapp Monarch Company, St. Louis, Mo.
C. P. Whitehead, General Steel Castings Corporation, Granite City, Ill.
National Council Representative: G. A. Waters, Wagner Electric Corporation, St. Louis, Mo.

San Francisco Post, October 17, 1923

President: J. M. Hait, Food Machinery and Chemical Corporation, San Jose, Calif.
Vice-Presidents: Elmer R. Peterson, Standard Oil Company of California, San Francisco, Calif.
William E. Butts, General Metals Corporation, Oakland, Calif.
Secretary-Treasurer: Col. Calvin A. Heath, San Francisco Ordnance District, 1515 Clay Street, Oakland 12, Calif.
Directors: Lawrence C. Ames, Irving Lundborg & Company, San Francisco, Calif.
Jack L. Ashby, Kaiser Steel Corporation, Oakland, Calif.
Lawrence S. Fletcher, attorney at law, Oakland, Calif.
B. C. Heacock, Caterpillar Tractor Co., Piedmont, Calif.
LeRoy Lutes, Mansfield Tire & Rubber Company, Oakland, Calif.
Elmer R. Peterson, Standard Oil Company of California, San Francisco, Calif.
Alden G. Roach, Columbia-Geneva Steel Division, United States Steel Corporation, San Francisco, Calif.
N. R. Sutherland, Pacific Gas & Electric Company, San Francisco, Calif.
William E. Waste, Bechtel Corporation, San Francisco, Calif.
Fred B. Whitman, Western Pacific Railroad Company, San Francisco, Calif.
National Council Representative: Lawrence S. Fletcher, attorney at law, Oakland, Calif.

Texas Post, October 30, 1942

President: K. P. Campbell, Sheffield Steel Corporation, Houston, Tex.
Vice-President: Allan D. Blackledge, Cameron Iron Works, Inc., Houston, Tex.
Secretary-Treasurer: Leo S. Bassett, Department of the Army, Dickson Gun Plant, P. O. Box 2545, Houston, Tex.
Directors: Dr. J. T. Elrod, University of Houston, Houston, Tex.
W. O. Hedrick, McEvoy Company, Houston, Tex.
N. E. Hull, Hughes Tool Company, Houston, Tex.
R. B. Kinzbach, Kinzbach Tool Company, Inc., Houston, Tex.
W. M. Powell, Brown & Root, Inc., Houston, Tex.
A. C. Sinclair, Long Reach Machine Works, Houston, Tex.
National Council Representative: Ross Stewart, Stewart & Stevenson Services, Houston, Tex.

Washington Post, November 18, 1925

President: Franklin B. Reybold, Alco Products, Incorporated, Washington, D. C.

Vice-Presidents: W. J. Sears, Rubber Manufacturers' Association, Washington, D. C.
Ernest A. Tupper, American Can Company, Washington, D. C.
Secretary-Treasurer: Stewart L. Magee, United States Steel Corporation, 1625 K Street, N.W., Washington 6, D. C.
Directors: R. W. Berry, Lycoming Division, Avco Manufacturing Corporation, Washington, D. C.
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R. P. Williams, Jr., Rheem Manufacturing Company, Washington, D. C.
National Council Representative: George M. Riveire, Goodyear Tire & Rubber Company, Washington, D. C.

Yankee Post, June 30, 1925

President: M. Edgar Fain, Tower Iron Works, Providence, R. I.
Vice-Presidents: John K. Ames, Burrows Corporation, Portland, Me.
Paul Sibley, Worcester Taper Pin Company, Worcester, Mass.
Paul F. Hannah, Raytheon Manufacturing Company, Waltham, Mass.
Secretary-Treasurer: John C. Dieselman, Morse-Smith-Morse Company, 165 Dexter Avenue, Watertown, Mass.
Directors: Charles C. Bell, Universal Winding Company, Cranston, R. I.
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National Council Representative: Harry A. Wansker, United-Carr Fastener Corporation, Cambridge, Mass.

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A liaison committee has been established by each of the armed services to strengthen the close tie between industry and the ordnance or armament personnel of each service through the American Ordnance Association. A Public Information Panel also has been formed to foster liaison between the press and the various segments of the Association. It is expected that these groups will be of value in industry-ordnance relations by bringing into focus many of the military production problems that American industry is able and eager to solve.

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Matériel Command, Headquarters, United States Air Force
Washington, D. C.

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Technical Divisions and Committees of the Association are voluntary advisory groups of qualified personnel, organized primarily along commodity lines, to serve the ordnance organizations of the Army, Navy, and Air Force and other agencies of the National Defense Establishment of the United States.

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DETROIT CONTROLS CORPORATION . DETROIT, MICH.
DETROIT DIESEL ENGINE DIVISION, GMC DETROIT, MICH.
DETROIT EDISON COMPANY . . . DETROIT, MICH.
DETROIT ENGINEERING & MACHINE CO. DETROIT, MICH.
DETROIT GASKET & MANUFACTURING COMPANY . . . . . DETROIT, MICH.
DETROIT HARVESTER COMPANY . . DETROIT, MICH.
DETROIT INSURANCE AGENCY . . . DETROIT, MICH.
DETROIT STAMPING COMPANY . . . DETROIT, MICH.
DETROIT STEEL CORPORATION . . DETROIT, MICH.
DETROIT STEEL PRODUCTS COMPANY . DETROIT, MICH.
DETROIT TRANSMISSION DIVISION, GMC . . . . . WILLOW RUN, MICH.
DEVLIEG MACHINE COMPANY . . . FERNDALE, MICH.
DIAMOND MATCH COMPANY . . . NEW YORK, N.Y.
DIAMOND T MOTOR CAR COMPANY . . CHICAGO, ILL.
DICTAPHONE CORPORATION . . BRIDGEPORT, CONN.
DIESEL EQUIPMENT DIVISION, GMC, GRAND RAPIDS, MICH.
DISSTON DIVISION, HENRY, H. K. PORTER COMPANY, INC. OF PITTSBURGH . . . PHILADELPHIA, PA.
DIVCO CORPORATION . . . . . DETROIT, MICH.
DIXIE CUP COMPANY . . . . . EASTON, PA.
DOALL COMPANY . . . . . DES PLAINES, ILL.
DODGE BROTHERS CORPORATION . . DETROIT, MICH.
DOUGLAS AIRCRAFT COMPANY SANTA MONICA, CALIF.
DOUGLAS & LOMASON COMPANY . . DETROIT, MICH.

Honor Roll of Industrial Preparedness

DRAPER CORPORATION . . . . HOPEDALE, MASS.
DRAVO CORPORATION . . . . . PITTSBURGH, PA.
DRUDGE BROTHERS MANUFACTURING COMPANY . . . . . OAKLAND, CALIF.
DUAL-MOTORS CORPORATION . . . DETROIT, MICH.
DUKANE CORPORATION . . . ST. CHARLES, ILL.
DUNCAN ELECTRIC MANUFACTURING COMPANY . . . . . LAFAYETTE, IND.
DUNHAM COMPANY, C. A. . . . . CHICAGO, ILL.
DU PONT DE NEMOURS & COMPANY, E. I. . . . . WILMINGTON, DEL.
DURHAM MANUFACTURING CORPORATION, MUNCIE, IND.
DURIRON COMPANY . . . . . DAYTON, OHIO

EAGLE-PICHER COMPANY . . . CINCINNATI, OHIO
EAGLE TOOL & MACHINE COMPANY SPRINGFIELD, OHIO
EAST COAST AERONAUTICS, INC. . . . PELHAM, N.Y.
EASTERN PRECISION RESISTOR CORPORATION . . . . . BROOKLYN, N.Y.
EASTERN STAINLESS STEEL CORPORATION . . . . . BALTIMORE, MD.
EASTERN TOOL & MANUFACTURING COMPANY . . . . . BELLEVILLE, N.J.
EASTMAN KODAK COMPANY . . . ROCHESTER, N.Y.
EATON MANUFACTURING COMPANY . CLEVELAND, OHIO
EBASCO SERVICES, INC. . . . . NEW YORK, N.Y.
ECLIPSE COUNTERBORE COMPANY . DETROIT, MICH.
ECONOMY ENGINEERING COMPANY WILLOUGHBY, OHIO
EDGEWATER STEEL COMPANY . . . PITTSBURGH, PA.
EDNALITE OPTICAL COMPANY . . . PEEKSKILL, N.Y.
EISEN BROTHERS, INC. . . . . HOBOKEN, N.J.
EKCO PRODUCTS COMPANY . . . . CHICAGO, ILL.
ELASTIC STOP NUT CORPORATION OF AMERICA . . . . . UNION, N.J.
ELECTRIC AUTO-LITE COMPANY . . . TOLEDO, OHIO
ELECTRIC FURNACE COMPANY . . . SALEM, OHIO
ELECTRIC STORAGE BATTERY COMPANY . . . . . PHILADELPHIA, PA.
ELECTRICAL ENGINEERING AND MANUFACTURING CORPORATION . . . . . LOS ANGELES, CALIF.
ELECTRO-MECHANICAL PRODUCTS COMPANY . . . . . GARDEN CITY, MICH.
ELECTRO REFRACTORIES & ABRASIVES CORPORATION . . . . . BUFFALO, N.Y.
ELECTRO TEC CORPORATION SOUTH HACKENSACK, N.J.
ELGIN NATIONAL WATCH COMPANY . . ELGIN, ILL.
ELKHART ENGINEERING CORPORATION, PLYMOUTH, WIS.
ELLIOTT COMPANY . . . . . JEANNETTE, PA.
ELLWOOD CITY FORGE COMPANY . ELLWOOD CITY, PA.
EMERSON ELECTRIC MANUFACTURING COMPANY . . . . . ST. LOUIS, MO.
EMERSON RADIO & PHONOGRAPH CORPORATION . . . . . NEW YORK, N.Y.
EMHART MANUFACTURING COMPANY . HARTFORD, CONN.
EMSCO MANUFACTURING COMPANY, LOS ANGELES, CALIF.
ENGLANDER COMPANY . . . . BIRMINGHAM, ALA.
ENTERPRISE MACHINE PARTS CORPORATION . . . . . DETROIT, MICH.
ENTERPRISE MANUFACTURING COMPANY AKRON, OHIO
ENTERPRISE TOOL & GEAR CORP. . . DETROIT, MICH.
ERCO DIVISION, ACF INDUSTRIES, INCORPORATED . . . . . HYATTSVILLE, MD.
ERIE FORGE & STEEL CORPORATION . . . ERIE, PA.
ESSEX BRASS CORPORATION . . . DETROIT, MICH.
ESSO RESEARCH & ENGINEERING COMPANY . . . . . NEW YORK, N.Y.
ESSO STANDARD OIL COMPANY . . NEW YORK, N.Y.
ETHYL CORPORATION . . . . . DETROIT, MICH.
EUCLID DIVISION, GMC . . . . CLEVELAND, OHIO
EUREKA WILLIAMS CORPORATION BLOOMINGTON, ILL.
EVANS PRODUCTS COMPANY . . PLYMOUTH, MICH.
EVANS RESEARCH AND DEVELOPMENT CORPORATION . . . . . NEW YORK, N.Y.
EVANS' SONS, INC., JOHN . . . PHILADELPHIA, PA.
EXACT WEIGHT SCALE COMPANY . . COLUMBUS, OHIO
EXCEL SPECIALTY CORPORATION . . . CHICAGO, ILL.
EX-CELL-O CORPORATION . . . . DETROIT, MICH.
EXPERIMENT INCORPORATED . . . RICHMOND, VA.

FABRICON PRODUCTS, INC. . . RIVER ROUGE, MICH.
FAFNIR BEARING COMPANY . . NEW BRITAIN, CONN.
FAIRBANKS COMPANY . . . . . NEW YORK, N.Y.
FAIRBANKS, MORSE & COMPANY . . . CHICAGO, ILL.
FAIRCHILD ENGINE AND AIRPLANE CORPORATION . . . . . DEER PARK, N.Y.
FALK CORPORATION . . . . MILWAUKEE, WIS.
FALSTROM COMPANY . . . . . PASSAIC, N.J.
FARBER, INC., S. W. . . . . NEW YORK, N.Y.
FARGO MOTOR CORPORATION . . . DETROIT, MICH.
FARRAND OPTICAL COMPANY . . . NEW YORK, N.Y.
FARREL-BIRMINGHAM COMPANY . . ANSONIA, CONN.
FASCO INDUSTRIES, INC. . . . . ROCHESTER, N.Y.
FAYSCOTT CORPORATION . . . . DEXTER, MAINE
FEDDERS-QUIGAN CORPORATION . . BUFFALO, N.Y.
FEDERAL LABORATORIES, INC. . . SALTSBURG, PA.
FEDERAL-MOGUL-BOWER BEARINGS, INCORPORATED . . . . . DETROIT, MICH.
FEDERAL MOTOR TRUCK COMPANY . DETROIT, MICH.
FEDERAL PACIFIC ELECTRIC COMPANY . NEWARK, N.J.
FEDERAL TELECOMMUNICATIONS LABORATORIES, DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORP. . . . . NUTLEY, N.J.
FEDERAL TELEPHONE AND RADIO COMPANY, DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORP. . . . . CLIFTON, N.J.
FELLOWS GEAR SHAPER COMPANY . SPRINGFIELD, VT.
FELT AND TARRANT MANUFACTURING COMPANY . . . . . CHICAGO, ILL.
FENN MANUFACTURING COMPANY NEWINGTON, CONN.
FENWAL INCORPORATED . . . . ASHLAND, MASS.
FERRACUTE MACHINE COMPANY . . BRIDGETON, N.J.
FIDELITY-PHILADELPHIA TRUST COMPANY . . . . . PHILADELPHIA, PA.
FIDELITY TRUST COMPANY . . . PITTSBURGH, PA.
FIFTH THIRD UNION TRUST COMPANY . . . . . CINCINNATI, OHIO
FILER & STOWELL COMPANY . . MILWAUKEE, WIS.
FIRESTONE TIRE & RUBBER COMPANY . AKRON, OHIO
FIRST FEDERAL SAVINGS & LOAN ASSOCIATION OF DETROIT . . . . . DETROIT, MICH

Honor Roll of Industrial Preparedness

FIRTH STERLING INC. . . . . PITTSBURGH, PA.
FISHER BODY DIVISION, GMC . . . DETROIT, MICH.
FITZGIBBONS BOILER COMPANY . . NEW YORK, N.Y.
FITZSIMONS MANUFACTURING COMPANY, DETROIT, MICH.
FLANNERY MANUFACTURING COMPANY, BRIDGEVILLE, PA.
FLETCHER AVIATION CORPORATION ROSEMEAD, CALIF.
FLOUR CITY ORNAMENTAL IRON COMPANY . . . . . MINNEAPOLIS, MINN.
FLYNN MANUFACTURING COMPANY, MICHAEL . . . . . PHILADELPHIA, PA.
FOOD MACHINERY AND CHEMICAL CORPORATION . . . . . SAN JOSE, CALIF.
FORD INSTRUMENT COMPANY, DIVISION OF SPERRY RAND CORPORATION . LONG ISLAND CITY, N.Y.
FORD MOTOR COMPANY . . . . . CHESTER, PA.
FORD MOTOR COMPANY . . . DEARBORN, MICH.
FOSTER WHEELER CORPORATION . . NEW YORK, N.Y.
FOUR WHEEL DRIVE AUTO COMPANY, CLINTONVILLE, WIS.
FRAM CORPORATION . . . . PROVIDENCE, R.I.
FRANTZ COMPANY, S. G. . . . . TRENTON, N.J.
FREBANK COMPANY . . . . GLENDALE, CALIF.
FRICK-GALLAGHER MFG. COMPANY . WELLSTON, OHIO
FRIGIDAIRE DIVISION, GMC . . . DAYTON, OHIO
FRUEHAUF TRAILER COMPANY . . DETROIT, MICH.
FULLER BRUSH COMPANY . . . HARTFORD, CONN.
FULLER MANUFACTURING COMPANY, KALAMAZOO, MICH.

GAGE PRODUCTS COMPANY . . . FERNDALE, MICH.
GAIR COMPANY, ROBERT . . . . NEW YORK, N.Y.
GAR WOOD INDUSTRIES, INC. . . . WAYNE, MICH.
GARRETT COMPANY, GEORGE K. . PHILADELPHIA, PA.
GATES RUBBER COMPANY . . . . DENVER, COLO.
GEHRINGER & FORSYTH . . . . DETROIT, MICH.
GENERAL AMERICAN TRANSPORTATION CORPORATION . . . . . CHICAGO, ILL.
GENERAL ANILINE & FILM CORP. . . NEW YORK, N.Y.
GENERAL COMMUNICATION COMPANY BOSTON, MASS.
GENERAL DYNAMICS CORPORATION . NEW YORK, N.Y.
GENERAL ELECTRIC COMPANY . . SCHENECTADY, N.Y.
GENERAL ELECTRIC COMPANY, ELECTRONICS DIVISION . . . . . SYRACUSE, N.Y.
GENERAL FILM LABORATORIES CORPORATION . . . . . HOLLYWOOD, CALIF.
GENERAL MALLEABLE CORPORATION WAUKESHA, WIS.
GENERAL METALFAB COMPANY . . . DALLAS, TEX.
GENERAL METALS CORPORATION, SAN FRANCISCO, CALIF.
GENERAL MOTORS CORPORATION . . DETROIT, MICH.
GENERAL MOTORS TRUCK & COACH DIV., GMC . . . . . PONTIAC, MICH.
GENERAL PRECISION EQUIPMENT CORPORATION . . . . . NEW YORK, N.Y.
GENERAL RAILWAY SIGNAL COMPANY ROCHESTER, N.Y.
GENERAL STEEL CASTINGS CORP. . GRANITE CITY, ILL.
GENERAL STEEL PRODUCTS CORPORATION, FLUSHING, N.Y.
GENERAL TEXTILE MILLS, INC. . . NEW YORK, N.Y.
GENERAL TIME CORPORATION . . . NEW YORK, N.Y.
GENERAL TIRE & RUBBER COMPANY . . AKRON, OHIO
GENISCO, INCORPORATED . . . LOS ANGELES, CALIF.
GERITY-MICHIGAN CORPORATION . . ADRIAN, MICH.
GEROTOR MAY CORPORATION . . . BALTIMORE, MD.
GERSTENSLAGER COMPANY . . . WOOSTER, OHIO
GIANNINI & COMPANY, G. M. . . PASADENA, CALIF.
GIBBS MANUFACTURING & RESEARCH CORPORATION . . . . . JANESVILLE, WIS.
GIBSON REFRIGERATOR COMPANY . GREENVILLE, MICH.
GIDDINGS & LEWIS MACHINE TOOL COMPANY . . . . . FOND DU LAC, WIS.
GILBERT & BARKER MANUFACTURING COMPANY . . . . WEST SPRINGFIELD, MASS.
GILFILLAN BROTHERS, INC. . . LOS ANGELES, CALIF.
GISHOLT MACHINE COMPANY . . . MADISON, WIS.
GIVEN MANUFACTURING COMPANY, LOS ANGELES, CALIF.
GLEASON WORKS . . . . . ROCHESTER, N.Y.
GLIDDEN COMPANY . . . . CLEVELAND, OHIO
GLOBE AMERICAN CORPORATION . . KOKOMO, IND.
GLOBE LIGHTING PRODUCTS, INC. . . BROOKLYN, N.Y.
GOODRICH COMPANY, B. F. . . . . AKRON, OHIO
GOODYEAR AIRCRAFT CORPORATION . . AKRON, OHIO
GOODYEAR TIRE & RUBBER COMPANY . AKRON, OHIO
GORHAM MANUFACTURING COMPANY PROVIDENCE, R.I.
GORTON MACHINE COMPANY, GEO. . . RACINE, WIS.
GOSS PRINTING PRESS COMPANY . . . CHICAGO, ILL.
GOULD-NATIONAL BATTERIES, INC. . ST. PAUL, MINN.
GRABLER MANUFACTURING CO. . CLEVELAND, OHIO
GRAFLEX, INC. . . . . ROCHESTER, N.Y.
GRAMMES AND SONS, INC., L. F. . . ALLENTOWN, PA.
GRAND RAPIDS BRASS COMPANY GRAND RAPIDS, MICH.
GRANITE CITY STEEL COMPANY . GRANITE CITY, ILL.
GRAY MARINE MOTOR COMPANY . . DETROIT, MICH.
GREAT LAKES STEEL CORPORATION . DETROIT, MICH.
GREENFIELD TAP AND DIE CORPORATION . . . . . GREENFIELD, MASS.
GREER HYDRAULICS, INC. . . . . BROOKLYN, N.Y.
GRIFFIN ENGINEERING DIVISION, SOUTHERN INDIANA MACHINE COMPANY . WEST NEWTON, IND.
GRINNELL CORPORATION . . . PROVIDENCE, R.I.
GROVES & SONS COMPANY, S. J. . MINNEAPOLIS, MINN.
GRUEN WATCH COMPANY . . . CINCINNATI, OHIO
GUARANTEE SPECIALTY MANUFACTURING COMPANY . . . . . CLEVELAND, OHIO
GUIDE LAMP DIVISION, GMC . . . ANDERSON, IND.
GULF OIL CORPORATION . . . . PITTSBURGH, PA.
GURLEY, W. & L. E. . . . . TROY, N.Y.

H & H MANUFACTURING COMPANY, CLIFTON HEIGHTS, PA
HAGAN CORPORATION . . . . . PITTSBURGH, PA.
HALL LAMP COMPANY, C. M. . . . DETROIT, MICH.
HALLER, RAYMOND AND BROWN, INC. . . . . STATE COLLEGE, PA.
HALOID COMPANY . . . . . ROCHESTER, N.Y.
HAMILTON FOUNDRY & MACHINE COMPANY . . . . . HAMILTON, OHIO
HAMILTON WATCH COMPANY . . . LANCASTER, PA.
HAMM COMPANY, DANIEL . . . . . ST. LOUIS, MO.
HANCOCK MANUFACTURING COMPANY JACKSON, MICH.
HANDY & HARMAN . . . . . NEW YORK, N.Y.
HANNIFIN CORPORATION . . . DES PLAINES, ILL.
HANSON-VAN WINKLE-MUNNING CO. . MATAWAN, N.J.
HARDY MANUFACTURING CORPORATION . . . . . UNION CITY, IND.

Honor Roll of Industrial Preparedness

HARNISCHFEGER CORPORATION . MILWAUKEE, WIS.
HARRINGTON & RICHARDSON, INC. WORCESTER, MASS.
HARRIS FOUNDRY & MACHINE COMPANY CORDELE, GA.
HARRIS-SEYBOLD COMPANY . . CLEVELAND, OHIO
HARRISBURG STEEL CORPORATION . HARRISBURG, PA.
HARSHAW CHEMICAL COMPANY . CLEVELAND, OHIO
HARVEY ALUMINUM SALES, INC. . TORRANCE, CALIF.
HAYS MANUFACTURING COMPANY . . . ERIE, PA.
HAZELTINE ELECTRONICS CORPORATION . . . . . LITTLE NECK, N.Y.
HECKETHORN MANUFACTURING & SUPPLY COMPANY . . . . . LITTLETON, COLO.
HEIL COMPANY . . . . . MILWAUKEE, WIS.
HEINEMANN ELECTRIC COMPANY . . . TRENTON, N.J.
HEINTZ MANUFACTURING COMPANY, PHILADELPHIA, PA.
HENDERSON NATIONAL BANK . . . HUNTSVILLE, ALA.
HENDRICK MANUFACTURING COMPANY . . . . . CARBONDALE, PA.
HEPPENSTALL COMPANY . . . . PITTSBURGH, PA.
HERCULES MOTORS CORPORATION . CANTON, OHIO
HERCULES POWDER COMPANY . . WILMINGTON, DEL.
HESSE-EASTERN DIVISION, FLIGHTEX FABRICS, INC. . . . . CAMBRIDGE, MASS.
HEYDEN CHEMICAL CORPORATION . . NEW YORK, N.Y.
HEYWOOD WAKEFIELD COMPANY . . GARDNER, MASS.
HIAWATHA OIL & GAS COMPANY . . PITTSBURGH, PA.
HICKS CORPORATION . . . . . BOSTON, MASS.
HIGGINS, INC. . . . . NEW ORLEANS, LA.
HIGH SPEED HAMMER COMPANY . . ROCHESTER, N.Y.
HIGH STANDARD MANUFACTURING CORPORATION . . . . . HAMDEN, CONN.
HILLER HELICOPTERS . . . . PALO ALTO, CALIF.
HI-Q DIVISION, AEROVOX CORPORATION . OLEAN, N.Y.
HOBART BROTHERS COMPANY . . . . TROY, OHIO
HOBART MANUFACTURING COMPANY . . TROY, OHIO
HOE & CO., INC., R. . . . . NEW YORK, N.Y.
HOEGANAES SPONGE IRON CORPORATION . . . . . NEW YORK, N.Y.
HOFFMAN LABORATORIES, INC. . LOS ANGELES, CALIF.
HOFMANN & COMPANY, ALFRED WEST NEW YORK, N.J.
HOHWIELER RUBBER COMPANY . . MORRISVILLE, PA.
HOLDEN COMPANY, A. F. . . . . DETROIT, MICH.
HOLLAND HITCH COMPANY . . . HOLLAND, MICH.
HOLLEY CARBURETOR COMPANY . VAN DYKE, MICH.
HOLO-KROME SCREW CORPORATION . ELMWOOD, CONN.
HOMAN & COMPANY . . . . CINCINNATI, OHIO
HOOVER COMPANY . . . . NORTH CANTON, OHIO
HOPKINS ENGINEERING COMPANY . ALTADENA, CALIF.
HOUDAILLE INDUSTRIES, INC. . . BUFFALO, N.Y.
HOUGH COMPANY, FRANK G. . . LIBERTYVILLE, ILL.
HOUGHTON & COMPANY, E. F. . PHILADELPHIA, PA.
HUBENY BROTHERS, INC. . . . . ROSELLE, N.J.
HUDSON SHARP MACHINE COMPANY . . . . . GREEN BAY, WIS.
HUGHES AIRCRAFT COMPANY . . CULVER CITY, CALIF.
HUGHES TOOL COMPANY . . . . HOUSTON, TEX.
HUGHES TOOL COMPANY, AIRCRAFT DIVISION . . . CULVER CITY, CALIF.
HUNTER DOUGLAS ALUMINUM CORPORATION . . . . . RIVERSIDE, CALIF.
HUNTER SPRING COMPANY . . . LANSDALE, PA.
HUPP CORPORATION . . . . . CLEVELAND, OHIO
HURD LOCK & MANUFACTURING COMPANY . . . . . DETROIT, MICH.
HUSSEY & COMPANY, C. G., DIVISION OF COPPER RANGE COMPANY . . . PITTSBURGH, PA.
HUSSMANN REFRIGERATOR COMPANY . ST. LOUIS, MO.
HYATT BEARINGS DIVISION, GMC . . HARRISON, N.J.
HYCON MANUFACTURING COMPANY PASADENA, CALIF.
HYDRAULIC PRESS MANUFACTURING COMPANY . . . . . MOUNT GILEAD, OHIO
HYDROPRESS, INC. . . . . NEW YORK, N.Y.

IDEAL INDUSTRIES, INC. . . . . SYCAMORE, ILL.
ILLINOIS GEAR & MACHINE COMPANY . . CHICAGO, ILL.
INDEPENDENT LOCK COMPANY . FITCHBURG, MASS.
INDIANA GEAR WORKS, INC. . . INDIANAPOLIS, IND.
INDUSTRIAL NATIONAL BANK-DETROIT DETROIT, MICH.
INDUSTRIAL TOOL & MACHINE CO. GEORGIAVILLE, R.I.
INGALLS IRON WORKS COMPANY . BIRMINGHAM, ALA.
INGRAHAM COMPANY, E. . . . . BRISTOL, CONN.
INLAND EQUIPMENT COMPANY . NASHVILLE, TENN.
INLAND MANUFACTURING DIV., GMC . DAYTON, OHIO
INLAND STEEL COMPANY . . . . . CHICAGO, ILL.
INMAN MANUFACTURING COMPANY . AMSTERDAM, N.Y.
INTERNATIONAL BUSINESS MACHINES CORPORATION . . . . . NEW YORK, N.Y.
INTERNATIONAL HARVESTER COMPANY . CHICAGO, ILL.
INTERNATIONAL NICKEL COMPANY, HUNTINGTON, W.VA.
INTERNATIONAL SILVER COMPANY . MERIDEN, CONN.
IONIA MANUFACTURING COMPANY, DIVISION, MITCHELL-BENTLEY CORPORATION . . IONIA, MICH.
ITHACA GUN COMPANY . . . . . ITHACA, N.Y.

JACKES-EVANS MANUFACTURING COMPANY . . . . . ST. LOUIS, MO.
JACKSON AND CHURCH COMPANY . . SAGINAW, MICH.
JACOBS COMPANY, F. L. . . . . DETROIT, MICH.
JARVIS ENGINEERING WORKS . . . LANSING, MICH.
JESSOP STEEL COMPANY . . . WASHINGTON, PA.
JOHNS-MANVILLE SALES CORPORATION, NEW YORK, N.Y.
JOHNSON & SON, INC., S. C. . . . . RACINE, WIS.
JOHNSON GAGE COMPANY . . . BLOOMFIELD, CONN.
JOHNSON SERVICE COMPANY . . MILWAUKEE, WIS.
JONES & LAMSON MACHINE COMPANY, SPRINGFIELD, VT.
JONES & LAUGHLIN STEEL CORPORATION . . . . . PITTSBURGH, PA.
JOY MANUFACTURING COMPANY . . PITTSBURGH, PA.

KABLE PRINTING COMPANY . . MOUNT MORRIS, ILL.
KAHN ASSOCIATED ARCHITECTS & ENGINEERS, INC., ALBERT . . . . . DETROIT, MICH.
KAISER AIRCRAFT & ELECTRONICS CORPORATION . . . . . OAKLAND, CALIF.
KAISER COMPANY, HENRY J. . . OAKLAND, CALIF.
KAISER METAL PRODUCTS, INC. . . . BRISTOL, PA.
KAISER STEEL CORPORATION . . OAKLAND, CALIF.
KAUPP & SONS, C. B. . . . . MAPLEWOOD, N.J.
KEARFOOT COMPANY . . . . LITTLE FALLS, N.J.

Honor Roll of Industrial Preparedness

KEARNEY & TRECKER CORPORATION WEST ALLIS, WIS.
KEEBLE ASSOCIATES, INC., EDWIN A., NASHVILLE, TENN.
KELLY-SPRINGFIELD TIRE COMPANY CUMBERLAND, MD.
KELSEY-HAYES WHEEL COMPANY . . DETROIT, MICH.
KENNAMETAL, INC. . . . . LATROBE, PA.
KENNEDY-VAN SAUN MANUFACTURING & ENGINEERING CORPORATION . . DANVILLE, PA.
KENT-MOORE ORGANIZATION, INC. . DETROIT, MICH.
KENWORTH MOTOR TRUCK COMPANY, DIVISION OF PACIFIC CAR AND FOUNDRY COMPANY, SEATTLE, WASH.
KEUFFEL & ESSER COMPANY . . . HOBOKEN, N.J.
KIDDE & COMPANY, WALTER . . . BELLEVILLE, N.J.
KILGORE, INC. . . . . WESTERVILLE, OHIO
KING POWDER COMPANY . . . CINCINNATI, OHIO
KING-SEELEY CORPORATION . . ANN ARBOR, MICH.
KNAPP-MONARCH COMPANY . . . ST. LOUIS, MO.
KOEHRING COMPANY . . . . MILWAUKEE, WIS.
KOHLER COMPANY . . . . . KOHLER, WIS.
KOLLSMAN INSTRUMENT CORPORATION ELMHURST, N.Y.
KOPPERS COMPANY . . . . . PITTSBURGH, PA.
KOVEN & BROTHER, INC., L. O. . . JERSEY CITY, N.J.
KWIKSET LOCKS, INC. . . . . ANAHEIM, CALIF.

LACLEDE STEEL COMPANY . . . . ST. LOUIS, MO.
LADISH COMPANY, TRI-CLOVER DIVISION . . . . . KENOSHA, WIS.
LANDERS FRARY & CLARK . . NEW BRITAIN, CONN.
LANGEVIN MANUFACTURING CORPORATION . . . . . NEW YORK, N.Y.
LANSDOWNE STEEL & IRON COMPANY . MORTON, PA.
LANSING DROP FORGE COMPANY . . LANSING, MICH.
LAPOINTE MACHINE TOOL COMPANY . HUDSON, MASS.
LEAR, INCORPORATED . . . GRAND RAPIDS, MICH.
LEBANON STEEL FOUNDRY . . . . LEBANON, PA.
LE BUS ROTARY TOOL WORKS, INC. . LONGVIEW, TEX.
LEE TIRE & RUBBER COMPANY OF NEW YORK, INC. . . . . CONSHOHOCKEN, PA.
LEECE-NEVILLE COMPANY . . . CLEVELAND, OHIO
LEEDS & NORTHRUP COMPANY . PHILADELPHIA, PA.
LEHIGH, INC. . . . . EASTON, PA.
LEMPCO PRODUCTS, INC. . . . . BEDFORD, OHIO
LENNOX FURNACE COMPANY . . . COLUMBUS, OHIO
LETOURNEAU, INC., R. G. . . . . LONGVIEW, TEX.
LEWYT MANUFACTURING CORPORATION, BROOKLYN, N.Y.
LIBBEY-OWENS-FORD GLASS COMPANY . TOLEDO, OHIO
LIEBERKNECHT, INC., KARL . . . . READING, PA.
LIGON BROTHERS . . . . . DETROIT, MICH.
LINCOLN ENGINEERING COMPANY . . ST. LOUIS, MO.
LINK AVIATION, INC. . . . . BINGHAMTON, N.Y.
LINK-BELT COMPANY . . . . . CHICAGO, ILL.
LIPE-ROLLWAY CORPORATION . . . SYRACUSE, N.Y.
LITTLE, INC., ARTHUR D. . . . CAMBRIDGE, MASS.
LOBDELL-EMERY MANUFACTURING CO. . ALMA, MICH.
LOCKHEED AIRCRAFT CORPORATION . BURBANK, CALIF.
LOCOMOTION ENGINEERING, INC. . SUNNYDALE, CALIF.
LOFSTRAND COMPANY . . . . . ROCKVILLE, MD.
LORRILLARD COMPANY, P. . . . NEW YORK, N.Y.
L-R HEAT TREATING COMPANY . . . NEWARK, N.J.
LUKENS STEEL COMPANY . . . . COATESVILLE, PA.
LYNCHBURG FOUNDRY COMPANY . . LYNCHBURG, VA.
LYON, INCORPORATED . . . . . DETROIT, MICH.
LYTLE ENGINEERING AND MANUFACTURING COMPANY . . . . . ALBUQUERQUE, N. MEX.

MACK MOLDING COMPANY, INC. . . . WAYNE, N.J.
MACK TRUCKS, INC. . . . . PLAINFIELD, N.J.
MACMANUS, JOHN & ADAMS, INC. . . . . BLOOMFIELD HILLS, MICH.
MADISON-KIPP CORPORATION . . . MADISON, WIS.
MAGNAFLUX CORPORATION . . . . CHICAGO, ILL.
MAGNAVOX COMPANY . . . . FORT WAYNE, IND.
MAGNETIC METALS COMPANY . . . . CAMDEN, N.J.
MAHON COMPANY, R. C. . . . . DETROIT, MICH.
MALL TOOL COMPANY . . . . . CHICAGO, ILL.
MANSFIELD TIRE & RUBBER COMPANY, MANSFIELD, OHIO
MANUFACTURERS NATIONAL BANK OF DETROIT . . . . . DETROIT, MICH.
MARKEM MACHINE COMPANY . . . . KEENE, N.H.
MARLBORO WIRE GOODS COMPANY . MARLBORO, MASS.
MARLIN FIREARMS COMPANY . . NEW HAVEN, CONN.
MARLIN-ROCKWELL CORPORATION JAMESTOWN, N.Y.
MARMON-HERRINGTON COMPANY . INDIANAPOLIS, IND.
MARTIN COMPANY, GLENN L. . . . BALTIMORE, MD.
MASCO SCREW PRODUCTS COMPANY DEARBORN, MICH.
MASON & HANGER-SILAS MASON COMPANY . . . . . NEW YORK, N.Y.
MASON COMPANY, L. E. . . . HYDE PARK, MASS.
MASSEY-HARRIS-FERGUSON, INC. . . . RACINE, WIS.
MATHEWS CONVEYOR COMPANY . ELWOOD CITY, PA.
MATHEWSON TOOL COMPANY . . WEST HAVEN, CONN.
MATTATUCK MANUFACTURING COMPANY . . . . . WATERBURY, CONN.
MAXSON CORPORATION, W. L. . . NEW YORK, N.Y.
MAYTAG COMPANY . . . . . NEWTON, IOWA
MCCONWAY & TORLEY CORPORATION . PITTSBURGH, PA.
MCCORD CORPORATION . . . . DETROIT, MICH.
MCGRAW ELECTRIC COMPANY . . . . CHICAGO, ILL.
MCINERNEY SPRING & WIRE COMPANY . . . . . GRAND RAPIDS, MICH.
MCINTOSH STAMPING CORPORATION . DETROIT, MICH.
MCKAY COMPANY . . . . . PITTSBURGH, PA.
MCKIERNAN-TERRY CORPORATION . HARRISON, N.J.
MCLOUTH STEEL CORPORATION . . DETROIT, MICH.
MCQUAY-NORRIS MANUFACTURING COMPANY . . . . . ST. LOUIS, MO.
MECHANICAL HANDLING SYSTEMS, INC. DETROIT, MICH.
MELLING FORGING COMPANY . . . LANSING, MICH.
MELLON NATIONAL BANK AND TRUST COMPANY . . . . . PITTSBURGH, PA.
MERGENTHALER LINOTYPE COMPANY . NEW YORK, N.Y.
MERKLE METAL PRODUCTS CORPORATION CHICAGO, ILL.
MERZ ENGINEERING, INC. . . . INDIANAPOLIS, IND.
MESTA MACHINE COMPANY . . . PITTSBURGH, PA.
METAL AUTO PARTS COMPANY . INDIANAPOLIS, IND.
METAL SPECIALTY COMPANY . . CINCINNATI, OHIO
METROPOLITAN BODY COMPANY . BRIDGEPORT, CONN.
MICA INSULATOR COMPANY . . SCHENECTADY, N.Y.
MICHIGAN CONSOLIDATED GAS COMPANY, DETROIT, MICH.
MICHIGAN STEEL TUBE PRODUCTS COMPANY . . . . . DETROIT, MICH.

Honor Roll of Industrial Preparedness

MICHIGAN TAG COMPANY . . GRAND RAPIDS, MICH.
MICHIGAN TOOL COMPANY . . . DETROIT, MICH.
MIDVALE-HEPPENSTALL COMPANY. PHILADELPHIA, PA.
MIDWAY COMPANY . . . . . NEWARK, N.J.
MID-WEST ABRASIVE COMPANY . . OWOSSO, MICH.
MILCO UNDERGARMENT COMPANY . BLOOMSBURG, PA.
MILLER MANUFACTURING COMPANY . DETROIT, MICH.
MILLER PRINTING MACHINERY COMPANY . . . . . PITTSBURGH, PA.
MINE SAFETY APPLIANCES COMPANY . PITTSBURGH, PA.
MINIATURE PRECISION BEARINGS, INC. . KEENE, N.H.
MINNEAPOLIS-HONEYWELL REGULATOR COMPANY . . . . . MINNEAPOLIS, MINN.
MINNEAPOLIS-MOLINE COMPANY . MINNEAPOLIS, MINN.
MISSION APPLIANCE CORPORATION WHITTIER, CALIF.
MISSISSIPPI RIVER FUEL CORPORATION ST. LOUIS, MO.
MODINE MANUFACTURING COMPANY . . RACINE, WIS.
MONARCH GOVERNOR COMPANY . . DETROIT, MICH.
MONARCH MARKING SYSTEM COMPANY DAYTON, OHIO
MONARCH RUBBER COMPANY . . . HARTVILLE, OHIO
MONROE AUTO EQUIPMENT COMPANY MONROE, MICH.
MONROE CALCULATING MACHINE COMPANY . . . . . ORANGE, N.J.
MONTPELIER MANUFACTURING CO. MONTPELIER, OHIO
MOORE DROP FORGING COMPANY . SPRINGFIELD, MASS.
MOORLANE COMPANY . . . . . TULSA, OKLA.
MORAINE PRODUCTS DIVISION, GMC . . DAYTON, OHIO
MORGAN ENGINEERING COMPANY . . ALLIANCE, OHIO
MORRISON STEEL PRODUCTS, INC. . BUFFALO, N.Y.
MORSE-SMITH-MORSE COMPANY . WATERTOWN, MASS.
MOSLER SAFE COMPANY . . . HAMILTON, OHIO
MOTOR PRODUCTS CORPORATION . . DETROIT, MICH.
MOTOR WHEEL CORPORATION . . . LANSING, MICH.
MOTOROLA, INC. . . . . CHICAGO, ILL.
MOTTER'S SONS, GEO. F. . . . . YORK, PA.
MOUNT CLEMENS METAL PRODUCTS COMPANY . . . . . MOUNT CLEMENS, MICH.
MUELLER CO. . . . . DECATUR, ILL.
MURRAY COMPANY OF TEXAS, INC. . . DALLAS, TEX.
MURRAY CORPORATION OF AMERICA . DETROIT, MICH.
MURRAY MANUFACTURING CORP. . . NEW YORK, N.Y.
MURRAY OHIO MANUFACTURING COMPANY . . . . . CLEVELAND, OHIO

NAGEL-CHASE MANUFACTURING COMPANY . . . . . CHICAGO, ILL.
NANKERVIS COMPANY, GEORGE L. . DETROIT, MICH.
NASH ENGINEERING COMPANY . . . . SOUTH NORWALK, CONN.
NATIONAL ACME COMPANY . . CLEVELAND, OHIO
NATIONAL AUTOMOTIVE FIBRES, INC. . DETROIT, MICH.
NATIONAL BANK OF DETROIT . . . DETROIT, MICH.
NATIONAL BROACH & MACHINE COMPANY . . . . . DETROIT, MICH.
NATIONAL CAN CORPORATION . . . CHICAGO, ILL.
NATIONAL CASH REGISTER COMPANY . . DAYTON, OHIO
NATIONAL EQUIPMENT CORPORATION NEW YORK, N.Y.
NATIONAL FIREWORKS ORDNANCE CORPORATION . . . . WEST HANOVER, MASS.
NATIONAL FORGE & ORDNANCE COMPANY IRVINE, PA.
NATIONAL GYPSUM COMPANY . . . BUFFALO, N.Y.
NATIONAL MACHINE PRODUCTS CO. . . UTICA, MICH.
NATIONAL MACHINERY COMPANY . . . TIFFIN, OHIO
NATIONAL MALLEABLE & STEEL CASTINGS COMPANY . . . . . CLEVELAND, OHIO
NATIONAL PNEUMATIC COMPANY, INC. AND HOLTZER-CABOT DIVISIONS . . . BOSTON, MASS.
NATIONAL POWDER COMPANY . . . ELDRED, PA.
NATIONAL PRESTO INDUSTRIES . . EAU CLAIRE, WIS.
NATIONAL REJECTORS, INC. . . . ST. LOUIS, MO.
NATIONAL RESEARCH CORPORATION CAMBRIDGE, MASS.
NATIONAL ROLL & FOUNDRY COMPANY AVONMORE, PA.
NATIONAL SCREW & MANUFACTURING COMPANY . . . . . CLEVELAND, OHIO
NATIONAL SUPPLY COMPANY . . . PITTSBURGH, PA.
NATIONAL TOOL SALVAGE COMPANY . DETROIT, MICH.
NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION . . . . PITTSBURGH, PA.
NATIONAL TWIST DRILL & TOOL COMPANY . . . . . ROCHESTER, MICH.
NATIONAL-U. S. RADIATOR CORPORATION . . . . . JOHNSTOWN, PA.
NATIONAL VENDORS, INC. . . . . ST. LOUIS, MO.
NEAPCO PRODUCTS, INC. . . . . POTTSTOWN, PA.
NESCO DIVISION OF NEW YORK SHIPBUILDING CORPORATION . . . . . GRANITE CITY, ILL.
NEVILLE CHEMICAL COMPANY . . . PITTSBURGH, PA.
NEW BRITAIN MACHINE COMPANY NEW BRITAIN, CONN.
NEW DEPARTURE DIVISION, GMC . . BRISTOL, CONN.
NEW HAMPSHIRE BALL BEARINGS, INC. . . . . PETERBOROUGH, N.H.
NEW HAVEN CLOCK AND WATCH COMPANY . . . . . NEW HAVEN, CONN.
NEW PROCESS GEAR CORPORATION . SYRACUSE, N.Y.
NEW YORK AIR BRAKE COMPANY . . NEW YORK, N.Y.
NEW YORK TRANSFORMER COMPANY . . ALPHA, N.J.
NEWARK STOVE COMPANY . . . NEWARK, OHIO
NIAGARA BLOWER COMPANY . . . NEW YORK, N.Y.
NORDBERG MANUFACTURING CO. . . MILWAUKEE, WIS.
NORDEN-KETAY CORPORATION . . NEW YORK, N.Y.
NORMA-HOFFMANN BEARINGS CORP. STAMFORD, CONN.
NORQUIST PRODUCTS, INC. . . JAMESTOWN, N.Y.
NORRIS, MANUFACTURER, INC., W. C. . TULSA, OKLA.
NORRIS-THERMADOR CORPORATION, LOS ANGELES, CALIF.
NORTH AMERICAN AVIATION, INC., LOS ANGELES, CALIF.
NORTHERN ORDNANCE INCORPORATED . . . . . MINNEAPOLIS, MINN.
NORTHFIELD FOUNDRY & MACHINE COMPANY . . . . . NORTHFIELD, MINN.
NORTHROP AIRCRAFT, INC., ANAHEIM DIVISION . . . . . ANAHEIM, CALIF.
NORTHWEST AUTOMATIC PRODUCTS CORPORATION . . . . . MINNEAPOLIS, MINN.
NORTON COMPANY . . . . . WORCESTER, MASS.

OAKITE PRODUCTS, INC. . . . . NEW YORK, N.Y.
OHIO RUBBER COMPANY . . . WILLOUGHBY, OHIO
OHIO STEEL FOUNDRY COMPANY . . . LIMA, OHIO
OILGEAR COMPANY . . . . . MILWAUKEE, WIS.
OILJAK MANUFACTURING COMPANY . MONTCLAIR, N.J.

Honor Roll of Industrial Preparedness

O'KEEFE & MERRITT COMPANY . LOS ANGELES, CALIF.
OLDSMOBILE DIVISION, GMC . . . LANSING, MICH.
OLIN MATHIESON CHEMICAL CORPORATION . . . . . BALTIMORE, MD.
OLIN MATHIESON CHEMICAL CORPORATION . . . . . NEW YORK, N.Y.
OLIVER CORPORATION . . . . . CHICAGO, ILL.
OLOFSSON CORPORATION . . . . LANSING, MICH.
ONONDAGA POTTERY COMPANY . . SYRACUSE, N.Y.
OPTICAL GAGING PRODUCTS, INC. . . ROCHESTER, N.Y.
OSTER MANUFACTURING COMPANY, JOHN, AVIONICS DIVISION . . . . RACINE, WIS.
OTIS ELEVATOR COMPANY . . . . NEW YORK, N.Y.
OVERTON MACHINE COMPANY . . DOWAGIAC, MICH.
OWENS-CORNING FIBERGLAS CORPORATION . . . . . WASHINGTON, D.C.

PACE CORPORATION . . . . BASE LINE, MICH.
PACIFIC CAR AND FOUNDRY COMPANY RENTON, WASH.
PACKARD ELECTRIC DIVISION, GMC . WARREN, OHIO
PANTEX MANUFACTURING CORPORATION . . . . . PAWTUCKET, R.I.
PARISH PRESSED STEEL, DIVISION OF DANA CORPORATION . . . . . READING, PA.
PARKER APPLIANCE COMPANY . CLEVELAND, OHIO
PARKER PEN COMPANY . . . . JANESVILLE, WIS.
PARKER RUST PROOF COMPANY . . DETROIT, MICH.
PASS & SEYMOUR, INC. . . . . SYRACUSE, N.Y.
PECO PLANT, JOHN BEAN DIVISION, FOOD MACHINERY AND CHEMICAL CORPORATION . PHILADELPHIA, PA.
PEERLESS OF AMERICA, INC. . . . CHICAGO, ILL.
PEMCO CORPORATION . . . . . BALTIMORE, MD.
PENNSYLVANIA SALT MANUFACTURING COMPANY . . . . . PHILADELPHIA, PA.
PEOPLES FIRST NATIONAL BANK & TRUST COMPANY . . . . . PITTSBURGH, PA.
PERFECTION STEEL BODY COMPANY . . GALION, OHIO
PERFEX CORPORATION . . . . MILWAUKEE, WIS.
PERMATEX COMPANY . . . . . BROOKLYN, N.Y.
PHELPS DODGE COPPER PRODUCTS CORPORATION . . . . . NEW YORK, N.Y.
PHILADELPHIA BRONZE & BRASS CORPORATION . . . . . PHILADELPHIA, PA.
PHILCO CORPORATION . . . . PHILADELPHIA, PA.
PHOENIX BRIDGE COMPANY . . PHOENIXVILLE, PA.
PICKANDS MATHER & COMPANY . CLEVELAND, OHIO
PIERCE GOVERNOR COMPANY, INC. . ANDERSON, IND.
PITNEY-BOWES, INC. . . . . STAMFORD, CONN.
PITTSBURGH COKE & CHEMICAL CO. . PITTSBURGH, PA.
PITTSBURGH CONSOLIDATION COAL COMPANY . . . . . PITTSBURGH, PA.
PITTSBURGH FORGINGS COMPANY . . CORAOPOLIS, PA.
PITTSBURGH PIPING & EQUIPMENT COMPANY . . . . . PITTSBURGH, PA.
PITTSBURGH PLATE GLASS COMPANY . PITTSBURGH, PA.
PITTSBURGH STEEL COMPANY . . . PITTSBURGH, PA.
PITTSBURGH STEEL FOUNDRY CORP. . PITTSBURGH, PA.
PITTSBURGH TUBE COMPANY . . . PITTSBURGH, PA.
PLUME & ATWOOD MANUFACTURING COMPANY . . . . . THOMASTON, CONN.
PLYMOUTH MOTOR CORPORATION . . DETROIT, MICH.
POLORON PRODUCTS, INC. . . . NEW ROCHELLE, N.Y.
PONTIAC MOTOR DIVISION, GMC . . PONTIAC, MICH.
PORCELAIN METALS CORPORATION . LOUISVILLE, KY.
PORTER COMPANY, H. K. . . . . PITTSBURGH, PA.
PORTLAND FORGE & FOUNDRY CO. . PORTLAND, IND.
PRATT & WHITNEY COMPANY, INC. . . . WEST HARTFORD, CONN.
PRECISION CASTINGS COMPANY . . SYRACUSE, N.Y.
PROCTER & GAMBLE COMPANY . CINCINNATI, OHIO
PROCTOR ELECTRIC COMPANY . . PHILADELPHIA, PA.
PROPULSION RESEARCH CORPORATION . . . . SANTA MONICA, CALIF.
PULLMAN-STANDARD CAR MANUFACTURING COMPANY . . . . . CHICAGO, ILL.
PYLE-NATIONAL COMPANY . . . . CHICAGO, ILL.

QUAKER STATE OIL REFINING CORPORATION . . . . . EMLENTON, PA.

RAILWAY SPECIALTIES CORPORATION . BRISTOL, PA.
RANDALL COMPANY, FRED M. . . . DETROIT, MICH.
RAY OIL BURNER COMPANY . SAN FRANCISCO, CALIF.
RAYTHEON MANUFACTURING COMPANY . . . . . WALTHAM, MASS.
RCA VICTOR DIVISION, RADIO CORPORATION OF AMERICA . . . . . CAMDEN, N.J.
REACTION MOTORS, INC. . . . . ROCKAWAY, N.J.
READING BATTERIES, INC. . . . . READING, PA.
READING COMPANY . . . . PHILADELPHIA, PA.
RED ARROW ELECTRONICS CORPORATION . . . . . BELLEVILLE, N.J.
RED LION CABINET COMPANY, REDCO TOOL DIVISION . . . . . RED LION, PA.
REED, SMITH, SHAW & MCCLAY . . PITTSBURGH, PA.
REEVES INSTRUMENT CORPORATION . NEW YORK, N.Y.
REGAL WARE, INC. . . . . KEWASKUM, WIS.
REGINA CORPORATION . . . . . RAHWAY, N.J.
REMINGTON ARMS COMPANY . . BRIDGEPORT, CONN.
REMINGTON RAND INC. . . . STAMFORD, CONN.
REO MOTORS, INC. . . . . LANSING, MICH.
REPUBLIC STEEL CORPORATION . CLEVELAND, OHIO
REVERE COPPER & BRASS, INC. . . NEW YORK, N.Y.
REYNOLDS ELECTRICAL & ENGINEERING COMPANY . . . . . EL PASO, TEX.
REYNOLDS METALS COMPANY . . . LOUISVILLE, KY.
REYNOLDS METALS COMPANY . . . RICHMOND, VA.
RHEEM MANUFACTURING COMPANY . NEW YORK, N.Y.
RICHARDS-WILCOX MANUFACTURING COMPANY . . . . . AURORA, ILL.
RICHFIELD OIL CORPORATION . . LOS ANGELES, CALIF.
RITEPOINT, INC. . . . . HERMANN, MO.
RIVERSIDE FOUNDRY, INC. . . BETTENDORF, IOWA
ROBBINS TIRE & RUBBER COMPANY . TUSCUMBIA, ALA.
ROBERTSHAW-FULTON CONTROLS COMPANY . . . . . GREENSBURG, PA.
ROBERTSON COMPANY, H. H. . . . PITTSBURGH, PA.
ROBINSON CLAY PRODUCTS COMPANY . . . . . AKRON, OHIO

Honor Roll of Industrial Preparedness

ROCHESTER PRODUCTS DIVISION, GMC, ROCHESTER, N.Y.
ROCKWELL MANUFACTURING COMPANY . . . . . PITTSBURGH, PA.
ROCKWOOD SPRINKLER COMPANY WORCESTER, MASS.
ROGERS CORPORATION . . . . . ROGERS, CONN.
ROHM & HAAS COMPANY . . . PHILADELPHIA, PA.
RONSON CORPORATION . . . . NEWARK, N.J.
ROPER CORPORATION, GEORGE D. . . ROCKFORD, ILL.
ROSS GEAR AND TOOL COMPANY . . LAFAYETTE, IND.
ROSS-MEEHAN FOUNDRIES . . CHATTANOOGA, TENN.
ROTARY ELECTRIC STEEL COMPANY . DETROIT, MICH.
ROY, INC., ROSS . . . . . DETROIT, MICH.
ROYAL TYPEWRITER COMPANY . HARTFORD, CONN.
ROYLYN INCORPORATED . . . GLENDALE, CALIF.
RUDEL MACHINERY COMPANY . . . NEW YORK, N.Y.
RUDISILL FOUNDRY COMPANY . . ANNISTON, ALA.
RULON COMPANY . . . . . CHICAGO, ILL.
RUST ENGINEERING COMPANY . . . PITTSBURGH, PA.
RYCO ENGINEERING, INC. . . . . DETROIT, MICH.
RYERSON & HAYNES, INC. . . . . JACKSON, MICH.

S & S CORRUGATED PAPER MACHINERY COMPANY . . . . . BROOKLYN, N.Y.
SACO-LOWELL SHOPS . . . . . BOSTON, MASS.
SAE STEELS . . . . . CLEVELAND, OHIO
SAGINAW MALLEABLE IRON DIVISION, GMC . . . . . SAGINAW, MICH.
SAGINAW STEERING GEAR DIVISION, GMC . . . . . SAGINAW, MICH.
ST. LOUIS CAR COMPANY . . . . ST. LOUIS, MO.
SANDERSON & PORTER . . . . NEW YORK, N.Y.
SANDIA CORPORATION . . . ALBUQUERQUE, N.MEX.
SANDPAPER, INC. . . . . ROCKLAND, MASS.
SANDY HILL IRON & BRASS WORKS . . . . . HUDSON FALLS, N.Y.
SAVAGE ARMS CORPORATION . . . . UTICA, N.Y.
SAWHILL TUBULAR PRODUCTS, INC. . . SHARON, PA.
SCAIFE COMPANY . . . . . PITTSBURGH, PA.
SCHAIBLE COMPANY . . . . CINCINNATI, OHIO
SCHLAGE LOCK COMPANY . . SAN FRANCISCO, CALIF.
SCHLITZ BREWING COMPANY, JOSEPH, MILWAUKEE, WIS.
SCHLUETER MANUFACTURING COMPANY, ST. LOUIS, MO.
SCHWITZER CORPORATION . . INDIANAPOLIS, IND.
SCOVILL MANUFACTURING COMPANY, WATERBURY, CONN.
SCRIPTO, INC. . . . . ATLANTA, GA.
SCULLIN STEEL COMPANY . . . . ST. LOUIS, MO.
SEARS, ROEBUCK AND COMPANY . . . CHICAGO, ILL.
SEIBERLING RUBBER COMPANY . . . AKRON, OHIO
SELF WINDING CLOCK COMPANY . . BROOKLYN, N.Y.
SERVEL, INC. . . . . EVANSVILLE, IND.
SESSIONS CLOCK COMPANY . . FORESTVILLE, CONN.
SEXTON CAN COMPANY . . . . EVERETT, MASS.
SHAKEPROOF, INC., DIV., ILLINOIS TOOL WORKS . . . . . ELGIN, ILL.
SHARON STEEL CORPORATION . . . . SHARON, PA.
SHEAFFER PEN COMPANY, W. A. FORT MADISON, IOWA
SHEFFIELD CORPORATION . . . . DAYTON, OHIO
SHEFFIELD STEEL DIVISION, ARMCO STEEL CORPORATION . . . KANSAS CITY, MO.
SHELL OIL COMPANY . . . . . NEW YORK, N.Y.
SHELLER MANUFACTURING CORPORATION . . . . . DETROIT, MICH.
SHERWIN-WILLIAMS COMPANY . CLEVELAND, OHIO
SIMMONS COMPANY . . . . . NEW YORK, N.Y.
SIMMONS MACHINE TOOL CORPORATION . ALBANY, N.Y.
SIMONDS SAW & STEEL COMPANY . FITCHBURG, MASS.
SINGER MANUFACTURING COMPANY, ELIZABETHPORT, N.J.
SKF INDUSTRIES, INC. . . . . PHILADELPHIA, PA.
SLAYMAKER LOCK COMPANY . . . LANCASTER, PA.
SMITH & CORONA TYPEWRITERS, INC., L. C. . . . . SYRACUSE, N.Y.
SMITH & WESSON, INC. . . . SPRINGFIELD, MASS.
SMITH COMPANY, S. MORGAN . . . . . YORK, PA.
SMITH COMPANY, T. L. . . . MILWAUKEE, WIS.
SMITH CORPORATION, A. O. . . MILWAUKEE, WIS.
SNYDER TOOL & ENGINEERING COMPANY . . . . . DETROIT, MICH.
SOCONY MOBIL OIL COMPANY, WHITE STAR DIVISION . . . . . DETROIT, MICH.
SOLAR AIRCRAFT COMPANY . . SAN DIEGO, CALIF.
SOLAR STEEL CORPORATION . . CLEVELAND, OHIO
SORENG PRODUCTS CORPORATION SCHILLER PARK, ILL.
SOUTH BEND LATHE WORKS . . SOUTH BEND, IND.
SOUTHEASTERN METALS COMPANY . . . . NORTH BIRMINGHAM, ALA.
SOUTHERN COACH MANUFACTURING COMPANY . . . . . EVERGREEN, ALA.
SOUTHERN NATURAL GAS COMPANY BIRMINGHAM, ALA.
SOUTHERN STATES EQUIPMENT CORPORATION . . . . . HAMPTON, GA.
SOUTHWEST STONE COMPANY . . . . DALLAS, TEX.
S-P MANUFACTURING CORPORATION CLEVELAND, OHIO
SPALDING & BROS., INC., A. G. . . CHICOPEE, MASS.
SPEED-O-PRINT CORPORATION . . . CHICAGO, ILL.
SPENCER CHEMICAL COMPANY . KANSAS CITY, MO.
SPERRY GYROSCOPE COMPANY, DIVISION, SPERRY RAND CORPORATION . . . GREAT NECK, N.Y.
SPERRY RAND CORPORATION . . . NEW YORK, N.Y.
SPRAGUE & CARLETON, INC. . . . . KEENE, N.H.
SPRAGUE ELECTRIC COMPANY . . NORTH ADAMS, MASS.
SQUARE D COMPANY . . . . . DETROIT, MICH.
STACKPOLE CARBON COMPANY . . ST. MARYS, PA.
STANDARD COIL PRODUCTS COMPANY . . . . . MELROSE PARK, ILL.
STANDARD CONTAINER, INC. . . . MONTCLAIR, N.J.
STANDARD FORGINGS CORPORATION . . CHICAGO, ILL.
STANDARD GAGE COMPANY . . POUGHKEEPSIE, N.Y.
STANDARD OIL COMPANY OF OHIO CLEVELAND, OHIO
STANDARD PRODUCTS COMPANY . . DETROIT, MICH.
STANDARD RAILWAY EQUIPMENT MANUFACTURING COMPANY . . . CHICAGO, ILL.
STANDARD SERVICE TIRE COMPANY, INC. . . . . SEATTLE, WASH.
STANDARD STEEL SPRING DIVISION, ROCKWELL SPRING AND AXLE COMPANY . . CORAOPOLIS, PA.
STANDARD TUBE COMPANY . . . DETROIT, MICH.
STA-RITE PRODUCTS, INC. . . . . DELAVAN, WIS.
STAVID ENGINEERING, INC. . . . PLAINFIELD, N.J.
STEARNS-ROGERS MANUFACTURING CO. DENVER, COLO.
STEEL IMPROVEMENT & FORGE CO. CLEVELAND, OHIO
STEEL PRODUCTS ENGINEERING CO. SPRINGFIELD, OHIO

Honor Roll of Industrial Preparedness

STEWART-WARNER CORPORATION . . CHICAGO, ILL.
STILE-CRAFT MANUFACTURERS, INC. . ST. LOUIS, MO.
STOCKHAM VALVES & FITTINGS . BIRMINGHAM, ALA.
STOKES MACHINE COMPANY, F. J. PHILADELPHIA, PA.
STOLLE CORPORATION . . . . CINCINNATI, OHIO
STOLTE, INC. . . . . OAKLAND, CALIF.
STONE & WEBSTER ENGINEERING CORPORATION . . . . . NEW YORK, N.Y.
STONER-MUDGE, INC. . . . . PITTSBURGH, PA.
STREETER-AMET COMPANY . . . . CHICAGO, ILL.
STRELINGER COMPANY, CHAS. A. . . DETROIT, MICH.
STROMBERG-CARLSON COMPANY, DIVISION OF GENERAL DYNAMICS CORPORATION ROCHESTER, N.Y.
STRONG STEEL FOUNDRY COMPANY . BUFFALO, N.Y.
STUART OIL COMPANY, D. A. . . . . CHICAGO, ILL.
STUDEBAKER-PACKARD CORPORATION DETROIT, MICH.
SUN ELECTRIC CORPORATION . . . . CHICAGO, ILL.
SUN OIL COMPANY . . . . . PHILADELPHIA, PA.
SUNDSTRAND MACHINE TOOL COMPANY ROCKFORD, ILL.
SUPER-VENT COMPANY . . . . . CHICAGO, ILL.
SUPERIOR COACH CORPORATION . . . LIMA, OHIO
SUPERIOR FOUNDRY, INC. . . . CLEVELAND, OHIO
SUPERIOR STEEL CORPORATION . . CARNEGIE, PA.
SUPREME KNITTING MACHINE CO. . OZONE PARK, N.Y.
SURFACE COMBUSTION CORPORATION . . TOLEDO, OHIO
SVERDRUP & PARCEL, INC. . . . ST. LOUIS, MO.
SWAN-FINCH OIL CORPORATION . HACKENSACK, N.J.
SWANK, INC. . . . . ATTLEBORO, MASS.
SWINDELL-DRESSLER CORPORATION . PITTSBURGH, PA.
SYLVANIA ELECTRIC PRODUCTS, INC. . NEW YORK, N.Y.
SYMINGTON-GOULD CORPORATION . . DEPEW, N.Y.
SYRACUSE INDUSTRIES, DIVISION OF UNION CHEMICAL & MATERIALS CORPORATION . . SYRACUSE, N.Y.

TALON, INC. . . . . MEADVILLE, PA.
TAYLOR & GASKIN, INC. . . . . DETROIT, MICH.
TECHNOLOGY INSTRUMENT CORPORATION ACTON, MASS.
TELEPHONICS CORPORATION . . HUNTINGTON, N.Y.
TEMCO AIRCRAFT CORPORATION . . . DALLAS, TEX.
TEMCO, INC. . . . . NASHVILLE, TENN.
TENNANT, SONS & COMPANY OF NEW YORK, C. . . . . NEW YORK, N.Y.
TENNESSEE COAL & IRON DIVISION, U. S. STEEL CORPORATION . . . . FAIRFIELD, ALA.
TENNESSEE CORPORATION . . . . NEW YORK, N.Y.
TENNESSEE EASTMAN COMPANY . KINGSPORT, TENN.
TERNSTEDT DIVISION, GMC . . . DETROIT, MICH.
TEXAS EASTERN TRANSMISSION CORPORATION . . . . . SHREVEPORT, LA.
TEXAS GULF SULPHUR COMPANY . . NEW YORK, N.Y.
TEXAS INSTRUMENTS INCORPORATED . . DALLAS, TEX.
TEXTILE MACHINE WORKS . . . . READING, PA.
THIOKOL CHEMICAL CORPORATION . . TRENTON, N.J.
THOMAS INDUSTRIES, INC. . FORT ATKINSON, WIS.
THOMAS MACHINE MANUFACTURING COMPANY . . . . . PITTSBURGH, PA.
THOMPSON & COMPANY, JOHN I. . WASHINGTON, D.C.
THOMPSON PRODUCTS, INC. . . CLEVELAND, OHIO
TIMKEN-DETROIT AXLE DIVISION, ROCKWELL SPRING AND AXLE COMPANY . . DETROIT, MICH.
TIMKEN ROLLER BEARING COMPANY . CANTON, OHIO
TIMMS SPRING COMPANY . . . . . ELYRIA, OHIO
TITAN METAL MANUFACTURING CO. . BELLEFONT, PA.
TITEFLEX, INC. . . . . NEWARK, N.J.
TOKHEIM CORPORATION . . . FORT WAYNE, IND.
TORRINGTON COMPANY . . . TORRINGTON, CONN.
TOWER IRON WORKS . . . . . PROVIDENCE, R.I.
TOWLE & SON COMPANY . . . CONSHOHOCKEN, PA.
TOWNSEND COMPANY . . . . NEW BRIGHTON, PA.
TRACTOMOTIVE CORPORATION . . DEERFIELD, ILL.
TRAILMOBILE, INC. . . . . CINCINNATI, OHIO
TRANSUE & WILLIAMS STEEL FORGING CORPORATION . . . . . ALLIANCE, OHIO
TREADWELL CONSTRUCTION COMPANY . MIDLAND, PA.
TREDEGAR COMPANY . . . . . RICHMOND, VA.
TRICO PRODUCTS CORPORATION . . BUFFALO, N.Y.
TRIFARI, KRUSSMAN & FISHEL, INC. PROVIDENCE, R.I.
TROJAN POWDER COMPANY . . . ALLENTOWN, PA.
TUBE REDUCING CORPORATION . WALLINGTON, N.J.
TULSA WINCH DIVISION, VICKERS, INC. . TULSA, OKLA.
TURCO PRODUCTS, INC. . . . LOS ANGELES, CALIF.
TURNER BRASS WORKS . . . . SYCAMORE, ILL.
TWIN DISC CLUTCH COMPANY . . . . RACINE, WIS.
TYLER REFRIGERATION CORPORATION . NILES, MICH.
TYSON BEARING CORPORATION . MASSILLON, OHIO

UDYLITE CORPORATION . . . . DETROIT, MICH.
ULTRASONIC CORPORATION . . CAMBRIDGE, MASS.
UNDERWOOD CORPORATION . . . NEW YORK, N.Y.
UNION BAG & PAPER CORPORATION . NEW YORK, N.Y.
UNION CARBIDE AND CARBON CORP. . NEW YORK, N.Y.
UNION METAL MANUFACTURING COMPANY, CANTON, OHIO
UNITED AIRCRAFT CORPORATION, EAST HARTFORD, CONN.
UNITED CAN DIVISION, AMERICAN SEAL-KAP CORPORATION . . . . . NEW VILLAGE, N.J.
UNITED-CARR FASTENER CORP. . CAMBRIDGE, MASS.
UNITED CHROMIUM, INC. . . . . NEW YORK, N.Y.
UNITED ENGINEERING & FOUNDRY CO., PITTSBURGH, PA.
UNITED METAL CABINET CORPORATION, POTTSVILLE, PA.
UNITED MOTORS SERVICE DIVISION, GMC, DETROIT, MICH.
UNITED SHOE MACHINERY CORPORATION, BOSTON, MASS.
UNITED STATES FLARE CORPORATION AND ASSOCIATED . . . . . PACOIMA, CALIF.
UNITED STATES HOFFMAN MACHINERY CORPORATION . . . . . NEW YORK, N.Y.
U. S. INDUSTRIAL CHEMICALS COMPANY, DIVISION OF NATIONAL DISTILLERS PRODUCTS CORPORATION . . . . . HUNTSVILLE, ALA.
U. S. INDUSTRIES, INC. . . . . NEW YORK, N.Y.
U. S. MACHINE DIVISION, STEWART-WARNER CORPORATION . . . . . LEBANON, IND.
UNITED STATES PIPE AND FOUNDRY COMPANY . . . . . BIRMINGHAM, ALA.
UNITED STATES RUBBER COMPANY . NEW YORK, N.Y.
UNITED STATES SPRING AND BUMPER COMPANY . . . . . LOS ANGELES, CALIF.
UNITED STATES STEEL CORPORATION . PITTSBURGH, PA.
UNITED STATES TIME CORPORATION, WATERBURY, CONN.
UNITED TUBE CORPORATION OF OHIO, CLEVELAND, OHIO
UNIVERSAL MATCH CORPORATION . ST. LOUIS, MO.

Honor Roll of Industrial Preparedness

UNIVERSAL OIL PRODUCTS COMPANY, DES PLAINES, ILL
UNIVERSAL WINDING COMPANY . . CRANSTON, R.I

VANDERCOOK & SONS, INC. . . . . CHICAGO, ILL.
VAN DORN IRON WORKS COMPANY CLEVELAND, OHIO
VAN KEUREN COMPANY . . . WATERTOWN, MASS.
VAN NORMAN COMPANY . . . SPRINGFIELD, MASS.
VARD, INC. . . . . PASADENA, CALIF.
VEEDER-ROOT, INC. . . . . HARTFORD, CONN.
VERSON ALLSTEEL PRESS COMPANY . . CHICAGO, ILL.
VERTOL AIRCRAFT CORPORATION . . . MORTON, PA.
VICKERS, INC. . . . . DETROIT, MICH.
VICTOR MANUFACTURING & GASKET COMPANY . . . . . CHICAGO, ILL.
VICTORY PLASTICS COMPANY . . . HUDSON, MASS.
VIKING TOOL & MACHINE CORPORATION, BELLEVILLE, N.J.
VISKING CORPORATION . . . . . CHICAGO, ILL.
VITRO CORPORATION OF AMERICA . NEW YORK, N.Y.
VOLCO BRASS AND COPPER COMPANY, KENILWORTH, N.J.

WADE ELECTRIC PRODUCTS CO. . . STURGIS, MICH.
WAGNER ELECTRIC CORPORATION . ST. LOUIS, MO.
WALD INDUSTRIES, INC. . . . . HUNTINGDON, PA.
WALSH CONSTRUCTION COMPANY . . PORTLAND, ME.
WALTERS MANUFACTURING COMPANY OAKMONT, PA.
WALTHAM WATCH COMPANY . . . WALTHAM, MASS.
WALWAY COMPANY . . . . . DETROIT, MICH.
WALWORTH COMPANY . . . . . NEW YORK, N.Y.
WARD LAFRANCE TRUCK CORPORATION . ELMIRA, N.Y.
WARE BROTHERS DIVISION, CHICAGO ROLLER SKATE COMPANY . . . . . CHICAGO, ILL.
WARNER & SWASEY COMPANY . CLEVELAND, OHIO
WARNER ELECTRIC BRAKE & CLUTCH COMPANY . . . . . BELOIT, WIS.
WARREN BROTHERS ROADS COMPANY, CAMBRIDGE, MASS.
WASHINGTON STEEL CORPORATION WASHINGTON, PA.
WATERBURY FARREL FOUNDRY & MACHINE COMPANY . . . . . WATERBURY, CONN.
WATSON MANUFACTURING COMPANY . JAMESTOWN, N.Y.
WAUKESHA MOTOR COMPANY . . . WAUKESHA, WIS.
WEATHERHEAD COMPANY . . . CLEVELAND, OHIO
WEBB COMPANY, JERVIS B. . . . DETROIT, MICH.
WEBSTER AND COMPANY, WARREN . . CAMDEN, N.J.
WEBSTER-CHICAGO CORPORATION . . . CHICAGO, ILL.
WEIRTON STEEL COMPANY . . . WEIRTON, W.VA.
WELEX JET SERVICES, INC. . . FORT WORTH, TEX.
WELLMAN COMPANY, S. K. . . . BEDFORD, OHIO
WELLS-GARDNER & COMPANY . . . . CHICAGO, ILL.
WERNER COMPANY, R. D. . . . . GREENVILLE, PA.
WEST BEND ALUMINUM COMPANY . WEST BEND, WIS.
WEST TIRE SETTER COMPANY . . . ROCHESTER, N.Y.
WESTERN ARC WELDING, INC. . . LOS ANGELES, CALIF.
WESTERN ELECTRIC COMPANY . . NEW YORK, N.Y.
WESTERN GEAR WORKS . . . . LYNWOOD, CALIF.
WESTINGHOUSE AIR BRAKE COMPANY, WILMERDING, PA.
WESTINGHOUSE ELECTRIC CORPORATION . . . . . PITTSBURGH, PA.
WETMORE HODGES AND ASSOCIATES, INC. . . . . REDWOOD CITY, CALIF.
WHEEL TRUEING TOOL COMPANY . . DETROIT, MICH.
WHEELABRATOR CORPORATION . MISHAWAKA, IND.
WHEELING STEEL CORPORATION . . WHEELING, W.VA.
WHEELOCK, LOVEJOY & COMPANY CAMBRIDGE, MASS.
WHELAND COMPANY . . . CHATTANOOGA, TENN.
WHIRLPOOL-SEEGER CORPORATION . ST. JOSEPH, MICH.
WHITE MOTOR COMPANY . . . CLEVELAND, OHIO
WHITE RODGERS ELECTRIC COMPANY . ST. LOUIS, MO.
WHITEHEAD & KALES COMPANY . RIVER ROUGE, MICH.
WHITEHEAD STAMPING COMPANY . . DETROIT, MICH.
WHITIN MACHINE WORKS . . WHITINSVILLE, MASS.
WHITTAKER GYRO, INC. . . . VAN NUYS, CALIF.
WIEGAND COMPANY, EDWIN L. . . PITTSBURGH, PA.
WILCOX FORGING CORPORATION . MECHANICSBURG, PA.
WILLYS MOTORS, INC. . . . . TOLEDO, OHIO
WINCHESTER REPEATING ARMS COMPANY . . . . . NEW HAVEN, CONN.
WINTER-WEISS COMPANY . . . . DENVER, COLO.
WISCONSIN MOTOR CORPORATION . . MILWAUKEE, WIS.
WOLVERINE FABRICATING & MANUFACTURING COMPANY . . . . . INKSTER, MICH.
WOLVERINE TUBE DIVISION, CALUMET & HECLA, INC. . . . DETROIT, MICH.
WOOD COMPANY, JOHN . . . CONSHOHOCKEN, PA.
WOOD COMPANY, R. D. . . . PHILADELPHIA, PA.
WOOD-MOSAIC COMPANY . . . . LOUISVILLE, KY.
WORCESTER TAPER PIN COMPANY WORCESTER, MASS.
WORDEN-ALLEN COMPANY . . MILWAUKEE, WIS.
WRIGHT MACHINE COMPANY . . WORCESTER, MASS.
WYANDOTTE CHEMICALS CORPORATION . . . . . WYANDOTTE, MICH.
WYCKOFF STEEL COMPANY . . . PITTSBURGH, PA.
WYSONG & MILES COMPANY . . GREENSBORO, N.C.

YODER COMPANY . . . . . CLEVELAND, OHIO
YORK CORPORATION . . . . . YORK, PA.
YOUNG RADIATOR COMPANY . . . . RACINE, WIS.
YOUNG SPRING & WIRE CORPORATION, L. A. . . . . DETROIT, MICH.
YOUNGSTOWN KITCHENS DIVISION, AMERICAN RADIATOR & STANDARD SANITARY CORPORATION . . . . . SALEM, OHIO
YOUNGSTOWN SHEET & TUBE COMPANY . . . . . YOUNGSTOWN, OHIO

ZELLER CORPORATION . . . . . DEFIANCE, OHIO
ZENITH RADIO CORPORATION . . . . CHICAGO, ILL.
ZIM MANUFACTURING COMPANY . . . CHICAGO, ILL.